Tintenbar to Ewingsdale

Environmental assessment

Working paper 4 – Terrestrial flora and fauna assessment

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Tintenbar to Ewingsdale Pacific Highway Upgrade:

Terrestrial Flora and Fauna Assessment

June 2008

Natural & Cultural Heritage Consultants 15-17 Henrietta St Chippendale NSW 2008

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Report for
Arup

Tintenbar to Ewingsdale Pacific Highway Upgrade: Terrestrial Flora and Fauna Report Assessment

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ABBREVIATIONS

CAMBA	China-Australia Migratory Bird Agreement
CAVS	Census of Australian Vertebrates
DECC	NSW Department of Environment and Climate Change (formerly DEC)
DEC	NSW Department of Environment and Conservation (currently DECC)
DEC Estate	National Parks and Nature Reserves owned by DEC
DEH	Commonwealth Department of the Environment and Heritage (currently DEWHA)
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (formerly DEH)
DOP	NSW Department of Planning (formerly Department of Planning Infrastructure and Natural Resources, DIPNR)
DNR	NSW Department of Natural Resources (formerly DIPNR)
DPI	NSW Department of Primary Industries (formerly NSW Fisheries)
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
FM Act	NSW *Fisheries Management* Act 1994
GIS	Geographic Information System
IBRA	Interim Biogeographic Regionalisation of Australia
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
KTP	Key Threatening Process
LGA	Local Government Authority
LWD	Large Woody Debris
MNES	Matters of National Environmental Significance
NPWS	NSW National Parks and Wildlife Service (now part of DECC)
RFI Act	*Rivers and Foreshores Improvement Act* 1948
ROTAP	Rare or Threatened Australian Plant
RTA	NSW Roads and Traffic Authority
SEPP	NSW State Environmental Planning Policy
SIS	Species Impact Statement
sp.	Species (singular)
spp.	Species (plural)
ssp.	subspecies
TSC Act	NSW *Threatened Species Conservation Act* 1995
var.	variety
WM Act	NSW *Water Management Act* 2000

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SUMMARY

Biosis Research Pty. Ltd. (Biosis) was commissioned by Arup on behalf of the NSW Roads and Traffic Authority (RTA) to carry out a terrestrial ecological assessment of the proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale on the NSW North Coast. This terrestrial ecological assessment has been undertaken to support the environmental assessment for the Project. The preferred route was announced by the Minister for Roads in September 2006.

The general aim of this assessment is to identify issues of conservation significance associated with the proposed upgrade. The specific objectives are:

- To conduct a literature review and database search for the study area.
- Undertake field surveys for terrestrial flora and fauna species and their habitats.
- Identify, map and describe the plant communities present and terrestrial habitat values associated with the study area.
- Assess the conservation significance of the study area in terms of threatened biota, important habitat and the role of the sites in the functioning of the broader landscape.
- Evaluate the impact of the proposed upgrade by undertaking impact assessments following the Part 3A Guidelines (DEC & DPI 2005) of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) for threatened biota as listed in the NSW *Threatened Species Conservation Act* 1995 (TSC Act) including the Director Generals Requirements (DGR's) for the project.
- Evaluate the impact of the proposed upgrade by implementing Significant Impact Criteria for threatened biota and migratory species as outlined in the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) including the Director General's Requirements for the project.
- Make recommendations to avoid potential impacts of the proposed upgrade on the terrestrical ecological values of the study area, and where avoidance is not possible, discuss and assess amelioration, mitigation and management measures to minimise impacts.
- Determine any requirements for a Referral to the Federal Minister for the Environment, Water, Heritage and the Arts under the provisions of the EPBC Act.

The terrestrial ecological field investigations of the proposed upgrade were conducted between 14 and 18 November 2006. Surveys were carried out using a combination of habitat based assessment and targeted sampling techniques.

The study area consists of the area of earthworks for the proposed road, the proposed road reserve and a buffer of approximately 50 m on either side of the proposed road reserve (Figure 1b). Standard practices were used to collect data and were based largely on guidelines developed by the NSW Department of Environment and Climate Change (DECC) for flora and fauna survey methods for Pacific Highway upgrade projects. The surveys were conducted in accordance with Part 3A of the EP&A Act and also the NSW NPWS Information Circular on Threatened Species Assessment. Surveys were carried out in November 2004/ 2005 /2006 so as to coincide with the flowering period of threatened plants and the activity period of threatened species of animal. This meant that all route options were surveyed and hence a wider area was surveyed than simply the proposed upgrade.

Flora

Three plant communities were recorded in the study area: Lowland Rainforest, Camphor Laurel and plantations. One of these, Lowland Rainforest, is listed as an Endangered Ecological Community (EEC) on the TSC Act. A Part 3A impact assessment determined that the impact of the proposed upgrade on this ecological community would be minimal.

Four threatened plant species were recorded in the study area: *Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei* and *Tinospora tinosporoides.*

Based on the Department of Environment and Climate Change (DECC) Atlas of NSW Wildlife and the Department of the Environment, Water, Heritage and the Arts (DEWHA) EPBC database, a total of 49 threatened species of plant must be considered under the TSC Act and /or EPBC Act. Of these, 36 have potential habitat within the study area as such impact assessments were required for these species.

Fauna

Sixty-seven species of vertebrate were recorded from within the study area, including five amphibians, two reptiles, seven mammals and 53 birds. All species recorded are native apart from the introduced Cane Toad. Five threatened species listed on the TSC Act were recorded: four mammals (Black Flying-fox *Pteropus alecto*, Grey-headed Flying-fox *Pteropus poliocephalus*, Little Bent-wing Bat *Miniopterus australis* and Large-footed Myotis *Myotis macropus* and one bird species (Masked Owl *Tyto novaehollandiae*). However, the Large-footed Myotis

is only a probable identification based on Anabat records[1]. Two bats of the *Nyctophilus* genus (i.e Long-eared Bats) were recorded by Anabats[1] during the survey (probable and possible identifications), and could be the threatened Eastern Long-eared Bat (*N. bifax*) or the common species *N. gouldi* or *N. geoffroyi.* The Grey-headed Flying Fox is listed on both the TSC and EPBC Acts. Two migratory species as listed under the EPBC Act were recorded in the area (Cattle Egret and Black-faced Monarch).

A total of 64 threatened or Migratory animal species or their habitat have been previously recorded within 10 km of the study area (DECC Atlas of NSW Wildlife of NSW Wildlife and DEWHA EPBC Online Database). Of the total, 47 have actual or potential habitat within the study area, as such, impact assessment of the proposed upgrade considered potential impacts on these 47 species.

Fauna habitat within the study area ranges from cleared vegetation which has low to moderate habitat quality in terms of fauna habitat characteristics, to fragmented small patches of native vegetation, including important habitat features such as tree hollows, riparian vegetation, fallen logs and feeding resources.

Wildlife Corridors and Connectivity

Throughout the region there are a number of large areas of vegetation in both the east and west, which either the existing highway traverses or the proposed upgrade would be likely to pass between. It should be noted that due to the large amount of clearing that has taken place in this landscape that even small patches of vegetation can be considered to be of high conservation value. A number of key habitat and corridors have been proposed by DECC (Scotts et al. 2000) and Byron Shire Council, which provide an indicative representation and consolidation of areas of potential high conservation value for priority forest fauna and habitat corridors that link these across the landscape. These areas of vegetation form part of a large network of vegetation patches and connectivity among them should be maintained wherever possible. At the regional scale, one sub-regional corridor linkages cross the study.

Impact Assessment

Impacts of the proposed upgrade are likely to come from a number of sources such as:

[1] The analysis of bat calls using the Anabat system is based on the characterization of echolocation calls, which are species specific (de Oliveira, 1998). If the call is short or if there is interference then sometimes the Anbat calls cannot be accurately assigned to species. During the characterization of calls, each call is assigned to a “definite”, “probable” or “possible” category. In the case of the Large-footed Myotis call in the current study, the call was short and it was assigned to a probable category.

- Vegetation clearance/habitat loss.
- Edge effects.
- Fragmentation of habitat.
- Mortality of individuals during both the construction and operations phases.
- Introduction and/or spread of weeds.

The key policy principle of the RTA's Road Development and Impact on Habitat Amelioration Measures is that "in principle, the planning and construction of roads should, in order of consideration endeavour to:

1. Avoid impacts on habitat though the planning process.
2. Minimise impacts on habitat through the planning process.
3. Mitigate impacts on habitat, through the use of a range of amelioration measures" (RTA 1998).

Where possible, important ecological features have been avoided during the initial route selection stage. Mitigation measures have been suggested to ameliorate impacts on terrestrial flora and fauna, including:

- Inclusion of fauna underpasses and barrier fencing to help animals move under the road and hence reduce mortality and barrier effects.
- Implementation of vegetation clearing procedures so that there is minimal disturbance to remaining flora and fauna.
- Fencing and protection of threatened plants that occur within the impact zone.
- Design of planting programs for the median strip so that fauna are not attracted to the road and mortality is minimised.
- Design of planting programs for the road reserve to provide habitat for fauna and minimise weed invasion.

Impact assessments as required under Part 3A of the EP&A and TSC Acts (DEC & DPI 2005) and Significant Impact Criteria Assessments as recommended under the EPBC Act Significant Impact Guidelines (DEH 2006b) were carried out for those species with potential habitat in the study area. The proposed upgrade of the Pacific Highway between Tintenbar to Ewingsdale is unlikely[2] to have a significant[3] impact on any species as determined under the EPBC Act. As such, a referral to the Federal Minister for the Environment, Water, Heritage and

[2] Taken to be not a real chance or possibility
[3] Taken to mean important, weighty or more than ordinary.

the Arts is not recommended. Further, the proposed upgrade is likely to have a minimal impact on any threatened species as determined under the EP&A and TSC Act.

1.0 INTRODUCTION

Biosis Research Pty. Ltd. (Biosis) was commissioned by Arup (contracting to the NSW Roads and Traffic Authority to investigate the terrestrial ecological aspects of the proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale on the NSW North Coast (the 'proposed upgrade').

This report is a working paper, which forms part of an environmental assessment (EA) prepared by Arup. This report is based on information regarding the proposed location, type and extent of works provided by Arup.

This Environmental Assessment draws upon the results of previous flora and fauna investigations undertaken for the proposed upgrade, including survey and assessment undertaken for the Terrestrial Ecology Preferred Route Report (Biosis Research 2005) and the Terrestrial Ecology Preliminary Assessment Report (Biosis Research 2006).

1.1 Objectives

This report has been prepared to meet the requirements of Part 3A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) as amended by the *Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Act* 2005 and in force as of 1 August 2005. Threatened biota as listed under the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) are considered. The requirements of the NSW *Water Management Act* 2000 (WM Act) and the *Rivers and Foreshores Improvement Act* 1948 (RFI Act) are also taken into account as are the NSW State Environmental Planning Policy 14 (SEPP 14) – Coastal Wetlands and the NSW State Environmental Planning Policy 44 (SEPP 44) – Koala Habitat Protection.

The principal objectives of this study are:

- To conduct a literature review and database search for the study area.
- Undertake field surveys for terrestrial flora and fauna species and their habitats.
- Identify, map and describe the plant communities present and terrestrial habitat values associated with the study area.
- Assess the conservation significance of the study areain terms of threatened biota, important habitat and the role of the sites in the functioning of the broader landscape.
- Evaluate the impact of the proposed upgrade by undertaking impact

assessments following the Part 3A Guidelines (DEC & DPI 2005) of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) for threatened biota as listed in the NSW *Threatened Species Conservation Act* 1995 (TSC Act).

- Evaluate the impact of the proposed upgrade by implementing Significant Impact Criteria for threatened biota and migratory species as outlined in the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).
- Make recommendations to avoid potential impacts of the proposed upgrade on the terrestrical ecological of the study area, and where avoidance is not possible, discuss and assess amelioration, mitigation and management measures to minimise impacts.
- Determine any requirements for a Referral to the Federal Minister for the Environment, Water, Heritage and the Arts under the provisions of the EPBC Act.

1.2 Study area

1.2.1 Definitions

New South Wales threatened species legislation applies particular definitions to the site of a proposed development and the area likely to be impacted by a proposed development. In addition, the present NSW and Commonwealth Government approach to biodiversity conservation recognises a system of "bioregions" and "subregions". In order to provide clarity of reporting and consistency with current legislation and policy, the following definitions apply throughout this document:

Proposed upgrade - proposed upgrade of the Pacific Highway between Tintenbar to Ewingsdale on the NSW North Coast;

Subject site – the area to be directly affected by the proposed upgrade (i.e. the development "footprint");

Study area – the Subject Site and any additional areas which are likely to be affected by the proposed upgrade, either directly or indirectly. In the case of the proposed upgrade, the study area includes the Subject Site (road footprint and 4 m buffer) and a 50 m buffer to account for any indirect impacts (387 ha);

Locality – for the purposes of this report, the "Locality" is defined as the area within a 10 km radius of the perimeter of the Subject Site;

Region – the region and sub-region in which the proposed upgrade would be

located, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA). The IBRA is based on Thackway and Cresswell (1995) and Morgan and Terry (1992) and periodically updated by Parks Australia. IBRA version 6.1 (DEH 2004a, b) was current at the time of this study. The proposed upgrade is located in the NSW North Coast Bioregion.

Threatened biota - threatened species, populations and ecological communities, or their potential habitats, as listed under the TSC Act or EPBC Act.

1.2.2 Location

The proposed upgrade would be located along an approximately 17 km route that commences in the south at Tintenbar and terminates in the north at Ewingsdale, bypassing the localities of Bangalow, Newrybar and Knockrow. The proposed upgrade would pass through the Local Government Areas (LGA's) of Ballina Shire and Byron Shire. The area is situated within the NSW North Coast bioregion (DEH 2004a) (Figure 1).

The study area is defined by the extent of direct and indirect impacts on flora and fauna that are likely to occur as a result of the proposed upgrade. Potential impacts on flora and fauna may occur during the construction and/or the subsequent operation of the proposed upgrade. Direct impacts are likely to be limited to the development footprint. Areas that may be indirectly affected by the proposed upgrade include adjoining flora and fauna habitats within 50 m of either side of the proposed upgrade. A distance of 50 m was chosen for the buffer as this is the average distance that edge effects are likely to be seen and recorded from the edge of a road (Biosis Research 2000, Bali 2005). Although edge effects (indirect impacts) can extend much further than 50 m, native vegetation patches immediately surrounding the proposed upgrade are only small and already completely edge effected, and therefore, a relatively small study area was chosen. Edge effects associated with roads are described in more detail in Section 5.1.3, but can be summarised as the degradation of adjacent habitat through (Bali 2000):

- Changes in microclimate, hydrology or floristics;
- Alteration to the pattern and frequency of fire;
- Invasion by exotic plant and animal species;
- Increase in sedimentation, tree death or rubbish and water pollution; and
- Improved access for predators.

The study area is divided into three sections (Figure 1):

- Ewingsdale/St Helena section;
- Bangalow/ Newrybar section; and,
- Emigrant Creek/Knockrow Section.

The study area is mainly surrounded by cleared agricultural land and Macadamia plantations, with some small scattered patches of regrowth native vegetation also occurring. Conservation nature reserves that occur locally include Tyagarah Nature Reserve (approximately 4 km north-east), Broken Head Nature Reserve (approximately 7.5 km east), Cumbebin Swamp Nature Reserve (approximately 4.5 km east), Uralba Nature Reserve (approximately 12 km to the south-west) and Ballina Nature Reserve (approximately 2 km south-east). There are two ecological items on the Register of the National Estate in the Locality: Killen Falls and Midgen Flat Scrub (also known as Hogan's Bluff). These remnants are significant as they are important examples of the vegetation that once existed much more extensively in the region and provide habitat for a number of native flora and fauna species, including threatened species.

1.2.3 Description

The study area mainly comprises privately owned rural and rural residential properties, collectively supporting houses, cleared paddocks, dams, landscaped gardens and a number of revegetation projects attempting to re-establish the native flora of the area. Small patches of regrowth native vegetation and isolated remnant trees are scattered throughout the majority cleared agricultural landscape. The main agricultural land use in the study area includes Macadamia plantations and cattle grazing. Macadamia Castle, a small themed tourist attraction, also occurs in the study area.

A number of major and local roads cross the study area, including the Pacific Highway, Ross Lane, Martins Lane, Old Byron Bay Road, Bangalow Road, St Helena Road and Ewingsdale Road. The Casino Murwillumbah Railway also crosses the study area.

A number of wildlife corridors identified by DECC and Byron Shire Council occur within the Locaility. One sub-regional wildlife corridor cross the study area in the northern section, lying along the St Helena Road ridgeline and then down to the coastal floodplains; a u-shaped sub-regional corridor to the southeast of Bangalow enters the east of the study area and links Newrybar Swamp with Piccadilly Hill; and, an east-west regional corridor immediately south of Tintenbar crosses the study area from Ballina Nature Reserve in the east to Emigrant Creek near Tintenbar in the west and south to Uralba Nature Reserve.

Riparian vegetation also provides a movement corridor along creek lines and rivers. Major creeks that occur within the study area include Emigrant Creek, Tinterbox Creek and Byron Creek.

1.3 Proposed Upgrade

The proposed upgrade is part of the overall Pacific Highway Upgrade Program and will consist of a 17 km four-lane divided carriage between Ross Lane and Ewingsdale (with potential to expand to six lanes if required), linking the northern end of the approved Ballina bypass to the existing dual carriageway at Ewingsdale (Arup 2006). This assessment only considers the impacts from the four-lane option.

2.0 METHODS

A number of terrestrial ecological investigations of the study area have been carried out, including:

- targeted surveys for threatened species in the study areafor the proposed upgrade on 14-18 November 2006; and,
- ground truthing of the constraints mapping (see Section 2.7.3) within the local area was undertaken as part of the route option development process, during field surveys on 1-2 and 14-15 November 2004, on 9-13 May 2005 and on 14-18 November 2005 (Biosis Research 2005, 2006).

The methods used to undertake these surveys are detailed below.

2.1 Approach

By design, this study was a habitat-based assessment and was conducted in accordance with the methodology employed for an assessment under Part 3A of the EP&A Act and the Part 3A Guidelines for Threatened Species Assessment (DEC & DPI 2005). Additional fauna survey techniques (e.g. spotlighting, Anabat etc) were employed to target threatened species thought to occur in the area as well as to gather information on groups of species and to assist in the compilation of species lists.

Some plant species that occur in the local area are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year. Other plant species are perennial, but are inconspicuous unless flowering. Similarly, some fauna may be seasonally absent from the study area. Some species that fall into these categories may not have been recorded

during the current study. However, threatened species that fall into these categories are still considered in the impact assessment, as the assessment is based on the presence or absence of suitable habitat for a threatened species, requiring only the presence of habitat, not individual records, for a threatened species to be considered further. The methodology employed for this assessment is sufficient to determine if the proposed upgrade would have a significant impact on any threatened terrestrial species, populations or ecological communities.

Access to private property

An attempt was made to contact all private land holders prior to and during the field trip to arrange access to their properties. In the majority of cases access was granted but in a small number of cases the owners could not be contacted or would not provide access. In these cases the property was not entered, but where possible was assessed from adjoining public lands or from land to which access had been granted.

2.2 Personnel Involved in Field Surveys

Personnel involved in the field surveys, the level of their experience and total number of hours spent conducting (or assisting in) surveys is shown below (Table 1). Curricula vitae of survey members are shown in Appendix 1.

Table 1: Personnel involved in field surveys

Name	Position	Qualifications	Experience	Role in project	Approximate No. of hours
Dr Rhidian Harrington	Zoologist Ecologist	BSc(Hons), MSc, PhD	13 years	Ecological survey design Fauna surveys Threatened fauna assessment Wildlife corridors Fauna crossing structures	125
Sian Wilkins	Botanist	BEnvSc (Hons)	5 years	Targeted flora surveys Ecological habitat assessment	125
Nathan Smith	Botanist	BSc	9 years	Targeted flora surveys Ecological habitat assessment	60
Terri English	Zoologist	BASc	7 years	Fauna surveys Threatened fauna assessment	60
Matthew Beitzel	Zoologist	BSc and BASc	5 years	Fauna surveys	15 hrs

2.3 Literature and Database Review

Literature Review

A list of documents examined for this project is provided below:

- Ballina Shire Council (2004) *State of Environment Report* (http://www.ballina.nsw.gov.au/cmst/ballina002/view_doc.asp?id=81&cat=65).
- Byron Shire Council (2004) *Draft Byron Biodiversity Conservation Strategy* (http://www.byron.nsw.gov.au/environ_planning.shtml).
- Bower Bush Works (2004) *Killen Falls Vegetation Restoration Management Plan*, Prepared for the Big Scrub Rainforest Landcare Group.
- Connell Wagner (1998) *Pacific Highway Ballina Bypass Environmental Impact Statement*. Prepared for the RTA.
- NPWS (1997a) *Big Scrub Nature Reserves (incorporating Andrew Johnston Big Scrub, Victoria Park, Davis Scrub, Hayters Hill, Boatharbour and Wilson Nature Reserve) Plan of Management*.
- NPWS (1998) *The Byron Coast Group of Nature Reserves Plan of Management (incorporating Brunswick Heads, Tyagarah and Broken Head Nature Reserves)*.
- Coyle (2002) *Environmental Repair and Enhancement Management Plan for Lot 2 DP 606347, Natural Lane, Broken Head*.
- Habitat Ecological Services (2005) *Flora and fauna assessment "Brookfarm" Lot 5 St Helena Road, St Helena*. A report to Brookfarm Pty. Ltd.
- Parker (1999) *Pacific Highway Upgrade, Bangalow to St. Helena, A Flora and Fauna Assessment.* Prepared for Maunsell McIntyre Pty Ltd.
- Parker (2002) *A Flora and Fauna Survey of Lot 2, DP 606347 Natural Lane, Broken Head*.
- Parker and S.J. Connelly (2004) *Nature Valley: Camphora Laurel Clearing Report*. Prepared for Byron Shire Council.
- Parker (2004, 2005) *Hidden Valley (Lot 2 DP 606347) Natural Lane, Broken Head: A supplementary environmental report*.
- Scotts *et. al.* (2000) *Key habitats and corridors for fauna: A landscape framework for bioregional conservation planning in North-east New South Wales. II. Methods, decision rules, assumptions and mapped outputs*, NPWS, Coffs Harbour.
- TW Dorey & Sons (Undated) *Vegetation Management Plan of TW Dorey & Sons property, Newrybar Valley*.

Database Searches

Records for terrestrial threatened biota as listed on the TSC Act were obtained from the Atlas of NSW Wildlife (DEC 2006a) within a 10 km radius of the study area using the Ballina and Lismore 1:100 000 map sheets. The database was searched on the 18 August 2004, 20 April 2005, 30 January 2006, 7 December 2006, 25 June 2007 and 11 Feruary 2008. The Atlas of NSW Wildlife is based on specific records provided by researchers and members of the public. Older data is entered on a 1 km grid and hence location is only accurate to within 1 km,

whereas more recent data is mapped more accurately. The Atlas of NSW Wildlife is not based on systematic surveys across New South Wales and the number of records tends to be biased towards coastal sites and towards areas where people commonly visit. It is also biased towards particular species, reserves and roads (Ewin 1997, NSW National Parks and Wildlife Service 1999).

Records for threatened biota and migratory species listed in the EPBC Act that potentially occur within a 10 km radius of the study area were obtained from the DEWHA's EPBC Online Database (DEH 2005). Database searches were conducted on the 20 April 2005, 30 January 2006, 4 December 2006, 12 June 2007 and 11 February 2008. The DEWHA's EPBC Online Database is based on predicted distributions compiled from a number of sources at various resolutions. Generally, where distributions are well known, maps have been derived from Recovery Plans, State vegetation maps, remote sensing imagery and detailed habitat studies. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data have been used to produce indicative distribution maps. For species whose distributions are less well known, point locations are collated from various sources and bioclimatic distribution models generated and then validated by experts. In some cases, distribution maps are based solely on expert knowledge (Environment Australia 2002).

The following species and ecological communities have not been mapped and do not appear in reports produced from the EPBC database:

- Threatened species listed as extinct or considered as vagrants.
- Some species and ecological communities that have only recently been listed.
- Cetaceans which are not listed as threatened.
- Some terrestrial species that over fly the Commonwealth marine area.,
- Migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- Non-threatened seabirds which have only been mapped for recorded breeding sites.
- Seals which have only been mapped for breeding sites near the Australian continent (Environment Australia 2002).

Further records of threatened species and information on vegetation mapping were obtained from the relevant literature listed above and from consultation with Byron Shire Council, Ian Gaskell (Ballina Shire Council) and James

Brideson (Ballina Shire Council), from information gathered at the community information sessions (CIS's) conducted in November 2004 and May 2005 as part of the options development process, and from discussions with numerous landowners.

2.4 Taxonomy

Plant taxonomy (method of classification) used in this report follows Harden (1992, 1993, 2000, 2002), and was verified by the Australian Plant Name Index (ANBG 2006). Other key references consulted for this report included (Williams *et al.* 1984, Williams and Harden 1987, Nicholson and Nicholson 1994a, b, 1995, 1996, 2000, Williams and Harden 2000, NPWS 2002a, Nicholson and Nicholson 2004). Difficult specimens were sent to the National Herbarium of NSW for positive identification. In the body of this report, plants are referred to by their scientific names only. Common names, where available, have been included in the Appendices.

Names of vertebrates follow the online Census of Australian Vertebrates (CAVs) data maintained by DEWHA (ABRS - Canberra 2006). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

2.5 Flora Survey

2.5.1 Flora Survey Effort

The terrestrial habitat assessment and flora survey was carried out by Nathan Smith and Sian Wilkins from 14 – 18 November 2006. Data from previous surveys was also used in the current report, including field surveys undertaken on 1-2 and 14-15 November 2004, on 9-13 May 2005 and on 14-18 November 2005 (Biosis Research 2005, 2006).

A cumulative total of approximately 185 person hours has been spent surveying the flora of the study area and surrounds.

2.5.2 Survey Design

Flora and plant communities were surveyed using the random-meander method, as described by Cropper (1993). The meander route is designed to traverse all communities and topographical features within the study area, recording plants as they are encountered. Potential habitat for threatened species was surveyed in greater detail and threatened plant species sightings were recorded during the

field survey, noting number of individuals and location information (GPS recording).

This approach aims to provide a list of dominant flora species within the study area. It does not seek to provide an exhaustive list of plants that occur within the study area, as may be achieved through a prolonged vegetation quadrat sampling program.

As indirect impacts to flora are not likely to extend further than 50 m from the edge of the proposed road (Biosis Research 2000, Bali 2005), detailed flora surveys were restricted to patches of vegetation that occur within the study area. Each patch of vegetation within the study area has, however, been ground truthed to determine the plant community present and its condition.

2.5.3 Vegetation Assessment

Ground truthing of base maps was undertaken by recording structural and floristic information for each plant community observed within the study area. An example of the datasheets used for the vegetation assessment can be provided on request.

Vegetation condition was assessed according to the degree it resembles relatively natural, undisturbed vegetation. Vegetation was assessed as being in good, moderate or poor condition or unnatural landscape according to the following criteria:

- species composition (species richness, degree of weed invasion);
- vegetation structure (representation of each of the original layers of vegetation);
- resilience (degree to which the natural soil profile of the area has been disturbed, affecting the capacity for natural regeneration).

The categories of vegetation conditions are as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and track margins; plant community contains original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) are intact, or if modified, natural soil profile remains intact.

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation are modified; vegetation layers (ground, shrub, canopy etc.) are largely intact, or if modified, natural soil profile remains intact; able to be regenerated to Good condition with minimal level of

management.

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation are highly modified; one or more original vegetation layers (ground, shrub, canopy etc.) are modified or missing, but natural soil profile intact; able to be regenerated to Moderate or Good condition with substantial management.

Unnatural Landscape: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition.

2.6 Fauna Survey

The fauna survey was largely habitat based in accordance with the DECC guidelines for the preparation of Assessment of Significance (NPWS 1996). The terrestrial habitat assessment and fauna survey was carried out by Rhidian Harrington and Terri-Ann English from 14 – 18 November 2006. Data from previous surveys was also used in the current report, including field surveys undertaken on 1-2 and 14-15 November 2004, on 9-13 May 2005 and on 14-18 November 2005 (Biosis Research 2005, 2006).

It should be noted that although the recording of threatened species from surveys can confirm their presence in a study area, the lack of threatened species records cannot be used to argue for the absence of the species from the site when suitable habitat is present. By the very nature of their rarity, threatened species are often difficult to detect. Therefore suitable habitat is the most important factor to consider when determining the presence of threatened species, although actual fauna surveys can be used to supplement this information, giving a better appreciation of species and habitat types present in the area.

Therefore to supplement the habitat surveys, species of animal using the study area were surveyed by undertaking active searching and listening as well as recording incidental observations. Standard survey methods were used to collect data relating to fauna and were based largely on guidelines developed by DECC. Both habitat assessment and fauna surveys methods are described in detail below.

2.6.1 Fauna Habitat Assessment

A general habitat based survey of the study area was carried out as well as an assessment of more specific habitat requirements of threatened species

previously recorded or likely to occur in the local area. The habitat assessment was used to predict the likely occurrence of threatened animals in the study area. Habitat characteristics can include structural features such as vegetation layers and fallen timber, feeding resources such as specific feed trees, or nesting resources such as tree hollows. Habitat requirements of threatened animals were determined from the literature as well as previous survey data detailing the habitat in which the species were recorded.

Three categories were used to evaluate general habitat value; Good, Moderate or Poor, as detailed below:

Good: ground flora containing a high number of indigenous species; plant community structure, ground, log and litter layer intact and undisturbed; a high level of breeding, nesting, feeding and roosting resources available; a high richness and diversity of native fauna species.

Moderate: ground flora containing a moderate number of indigenous species; plant community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna species.

Poor: ground flora containing a low number of indigenous species, plant community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native fauna species.

Other habitat features, such the value of the study areaas a habitat corridor, or the presence of remnant communities, or unusual ecological plant community structure, were also used to assess habitat quality.

As well as the general habitat features detailed above, specific habitat features were noted for individual species. For example, *Allocasuarina* spp. (She-Oaks) is an important foraging resource for Glossy Black-Cockatoos and is an indicator of potential habitat for this species. The presence or absence of potential habitat for each threatened species that has been recorded in the local area was recorded for each section of road.

2.6.2 Diurnal Bird Surveys

Diurnal bird species were surveyed by either direct observation using 10 x 42 field binoculars or by their calls. Surveys were carried out at different times of day including dusk and dawn. Two observers were involved in each survey, which included walking along tracks and roads within the study area. Additionally, incidental observations of birds were made during the habitat-based

assessment.

2.6.3 Spotlighting

Spotlighting was undertaken at night to detect nocturnal fauna including mammals, birds, reptiles and frogs. This involved the use of at least two 100 watt, 12 volt spotlights. Trails and roads within forest/woodland areas were traversed on foot or from a slow-moving vehicle during the night. Ground areas and tree canopies were searched for mammal and bird activity. Creeks, drainage lines and ponds were searched for frog species using two head-mounted spotlights.

2.6.4 Frog Surveys

Frogs were surveyed in the study area by walking around creeks and dams at night, listening for frog calls and actively searching vegetation on the waters edge using head torches.

2.6.5 Bat Detection

An Anabat detector (Titley Electronics) with time delay switch was used to record Microchiropteran bat calls (echolocation). Calls can provide information on frequency and call sequence, allowing species identification. The detector was set before dusk within or near a suspected bat fly-way, leaving it to record for a period of time. Fly-ways may include overgrown tracks and roads, beneath the canopy of streams and creeks, over larger water bodies (ponds, lakes) or within gaps or along edges of forest/woodland vegetation. A night switch ensured that recording started at dusk. A hand-held detector was used during first survey while spotlighting was undertaken, to record any bats flying past.

Bat calls were analysed by Narawan Williams (Ecotone Ecological Consultants) for species identification.

2.6.6 Call Playback

Nocturnal species with large home-ranges or those that are particularly cryptic are generally difficult to locate during nocturnal spotlighting but may be detected using call playback. This technique relies on behavioural responses associated with territory and threat, whereby emitted calls may induce a defending response (either call or display) from individuals of the same species. Owls can be surveyed in this manner (Kavanagh and Peake 1993), as well as other nocturnal vocalising animals such as mammals (Koala). Taped calls of each species were played through a loudspeaker (five minutes) to prompt a response call; this

was followed by a five minute period of quiet listening. Following completion of all species, the direct area surrounding the call playback was searched using a 100-watt spotlight.

2.6.7 Incidental observations

Both indirect and direct evidence of fauna were recorded and used to identify species presence. Direct evidence of animal species includes actual sightings or identification of the species by calls (e.g. birds, frogs and some nocturnal mammals). Indirect evidence of animal species includes remains (e.g. bones, skin and fur), scats (droppings), diggings or burrows, and hair or body remains identified from predator scats.

2.6.8 Weather conditions

The surveys were conducted over a week in November 2006. The average weather conditions experienced during this time are described in Table 2. It should be noted that the study area received approximately 70mm of rain in the two prior to the survey period although no rain was recorded during the surveys.

Table 2 : Average weather condition during survey period.

Date	Weather Conditions				
	Cloud cover	**Wind direction and speed**	**Temperature (C)**	**Moon**	**Rain**
14/11/06	6	South-easterly; moderate wind	25	0	0
15/11/06	1	South-easterly; light wind	27	0	0
16/11/06	5	Southerly; moderate to strong	25	0	0
17/11/06	1	Southerly; moderate wind	27	0	0
18/11/06	1	Southerly; light wind	27	0	0

Key; Cloud cover = recorded in eights of sky; Rain: 0 = none, 1 = drizzle – light, 2 = drizzle – heavy, 3 = heavy rain; Moon: 0 = none, 1 = ¼ moon, 2 = ½ moon, 3 = ¾ moon, 4 = full moon.

2.6.9 Fauna Survey Effort

The survey effort for the fauna survey is shown in Table 3. In addition to the direct fauna survey shown in this table, the botanists also made incidental observations of fauna while undertaking the flora surveys (see and Section 3.4.1).

The survey effort and associated investigations were considered sufficient to record extant threatened species (and/or their habitats) or the potential for them to occur and undertake an impact assessments (Assessment of Significance (as required under Part 3a of the EP&A Act).

Table 3: Survey effort for the fauna surveys.

Method	Survey effort
Habitat Assessments	7 hours
Spotlighting	6 hours
Anabat	8 nights
Call Playback	2 hours
Nocturnal Herpetofauna Survey	2 .75 hours
Diurnal Bird Survey	7 hours
Incidental Observations	19 days

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2.6.10 Anecdotal information

While accessing properties and moving through the local area, staff had discussions with property owners and locals regarding species that they had observed within the study area. While these anecdotal observations have been included in the species list, where actual observations were made during the field surveys these records take precedence.

2.7 Data Analysis

2.7.1 Database

The compiled plant species list for the study area was entered into the NSW Flora Information System (FIS) Database (Gullan *et al.* 2001), and fauna surveys results were entered into the Company Vertebrate Database; both databases ensures data security and allows efficient data manipulation and presentation.

2.7.2 Consultation

Biosis Research acknowledges the additional expert advice and local knowledge

on the vegetation of the study area from:

- Hank Bower (Byron Shire Council)
- Ian Gaskell (Ballina Shire Council)
- James Bridson (Ballina Shire Council)
- Barbara Stewart (DECC, Grafton)

2.7.3 Constraints Assessment

The constraints assessment was undertaken for the route development phase of the project (Biosis Research 2005, 2006), to enable the impacts of each route option of the proposed upgrade to be evaluated. Since the results of this assessment are utilised in the mapping of this report, the methods of the constraints assessment are detailed below.

Assessment of the conservation significance of each vegetation patch within the study area was based on a combination of the following factors:

- Size;
- Connectivity;
- Occurrence of significant plant and/or animal species;
- Occurrence of significant plant communities and/or habitats;
- Formal conservation/reserve status; and,
- Ecological integrity.

The significance of vegetation patches within the study area was evaluated on a geographical scale with four levels: National, State, Regional and Local. Due to the depletion and destruction of native vegetation across NSW, all native vegetation is considered to have at least Local significance.

Definitions of Low, Medium and High Terrestrial Ecological Constraints Classifications

All vegetation patches were classified according to their terrestrial ecological constraint, as summarised in Table 4. Patches of vegetation, including Camphor Laurel (an introduced tree species), that are known to contain threatened species had their constraint rating increased by one level. Generally, classes “High” and “Medium” can be defined as native vegetation (of varying quality) and “Low” as introduced species (Camphor Laurel and eucalypt/pine plantations).

Due to the high prevalence of Camphor Laurel within vegetation patches in the study area, the classification of vegetation patches were further defined based on

the amount of Camphor Laurel within them:

- High: Rainforest patch with no or minimal Camphor Laurel, or Rainforest with moderate Camphor Laurel within a DEC wildlife corridor;
- Medium: Rainforest with moderate Camphor Laurel, Camphor Laurel within a DEC wildlife corridor and patches of Camphor Laurel that are known to contain threatened species; and,
- Low: Camphor Laurel and pine and eucalypt plantations.

The amount of Camphor Laurel in the vegetation patches was broadly estimated based on relative species dominance observed during the ground-truthing and habitat assessment surveys.

Constraints within the study area, as defined in Table 4, are displayed in Figure 3.

Table 4: Constraint classification for terrestrial ecology

Constraints Classification	Description
Very high constraints	National Parks Estate (i.e. National Parks and Nature Reserves), SEPP 14 Wetlands and ecological sites listed on the Register of the National Estate (RNE). There is one ecological item on the RNE within the study area, Killen Falls Scrub. This remnant is significant as it is an important example of the vegetation that once existed much more extensively in the region and is habitat for a number of native flora and fauna species, including many threatened species. There are no other "Very High" constraints within the study area, although some occur to the east.
High constraints	Any native vegetation that is classified as an Endangered Ecological Community, mapped by DECC (Scotts *et.* al. 2000) as occurring within a regional or sub-regional wildlife corridor and/or as key habitat, and large patches of native vegetation and smaller patches connected to contiguous native vegetation, as they have high connectivity and/or intrinsic habitat value. Any native vegetation mapped by Byron Shire council as of High Conservation Value or as occurring within a wildlife corridor. Additionally, any vegetation patches on properties that are participating in the Land for Wildlife program or revegetation programs co-ordinated by BSRLG (regardless of age).
Medium constraints	All other native vegetation as it is of local significance. Additionally, Camphor Laurel mapped as occurring within DEC regional or sub-regional wildlife corridors or that is known to contain threatened species.
Low constraints	Camphor Laurel outside wildlife corridors and plantations as they have limited conservation value, although it is recognised that patches of Camphor Laurel provide habitat for some threatened plant and animal species (e.g. *Tinospora tinosporoides* and Rose-crowned Fruit-dove).

2.7.4 Vegetation Mapping

Vegetation patches within the study area were initially mapped based on:

- aerial photography,

- information gathered at the Community Information Sessions,
- DECC mapping of corridors and key habitat (Scotts *et. al*. 2000),
- presence of threatened species (DECC Atlas of NSW Wildlife, Byron and Ballina Council records, property owner records, records from this study); and,
- Byron Shire Council mapping (vegetation, High Conservation Value (HCV), fauna models and wildlife corridors).

Ground truthing of the constraints mapping within the study area was undertaken during three field surveys on 1-2 and 14-15 November 2004, 9-13 May 2005 and 14-18 November 2005. Surveys undertaken between 14 and 18 November 2006 collected additional data about the species composition and vegetation structure of the patches of vegetation within the Subject Site.

2.8 Impact Assessment

An assessment of the impact of the proposed upgrade on native flora and fauna was made based on data described above and on the EPBC Act Significant Impact Guidelines (DEH 2006b) and the Part 3A Guidelines for Threatened Species Assessment under the EP&A Act (DEC & DPI 2005).

The extent of native vegetation clearing was measured based on the extent of new earthworks plus a buffer of 4 m (using the Preferred Route Draft Concept Design v10.0). The distance of 4 m allows for any construction activities adjacent to the earthworks and the inclusion of structures such as drains and sediment ponds. The use of this line is a better estimate of the true extent of vegetation clearing than simply using the extent of earthworks. The extent of vegetation clearing was based on native vegetation within the boundary just described.

The extent of edge effects was measured using the same boundary described above (i.e. the extent of earthworks plus a buffer of 4 m). Edge effects were calculated based on the area of native vegetation within a distance of 50 m (see section 5.1.3). For areas adjacent to already existing carriageways, the edge effects were estimated from the existing boundary of vegetation adjacent to the road. It should be noted however, that due to the small size of the patches of vegetation in the study area, they are already completely edge affected and no new edges are created by the proposed upgrade.

3.0 POLICY CONTEXT AND LEGISLATIVE FRAMEWORK

This assessment has included reference to species, populations and communities listed on the TSC Act as well as species listed on the EPBC Act. The Commonwealth and NSW Acts and policies that apply to the study area with regard to terrestrial flora and fauna are discussed below.

3.1 Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

Under the provisions of the EPBC Act any action (activity or development) that requires Commonwealth approval is deemed a controlled action. This is usually the case when an action is likely to have a significant effect on the environment of Commonwealth land or any 'Matter of National Environmental Significance' (MNES) listed below:

- World Heritage areas;
- Wetlands protected by international treaty (Ramsar Convention);
- Nationally listed threatened species and ecological communities;
- Internationally listed migratory species- Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) & Bonn Convention;
- All nuclear actions; and,
- The environment of Commonwealth marine areas.

Where an impact is of potential significance then those affected species or habitats must be referred (Referral) to DEWHA for assessment in accordance with specific criteria outlined in the Guidelines for Significance Assessment. These guidelines provide separate criteria for Extinct, Vulnerable, Endangered and Migratory species against which the significance of the impact can be assessed and whether a Referral is required. The purpose of the referral stage is to determine whether a proposed action requires approval under the EPBC Act. If the Minister determines that an approval is required, the proposed action will proceed through the assessment and approval process.

A Referral is a set of information that includes brief descriptions of the proposed upgrade, its location and potential impacts on matters of national environmental significance. The EPBC Regulations set out what information must be included in the referral.

If a proposed action has been referred to the Commonwealth Environment Minister and the Minister has decided that the action requires approval, an environmental assessment must be carried out in accordance with DEWHA

requirements.

The purpose of an environmental assessment is to bring together all the information on the impacts that a proposed action would have on matters protected by the EPBC Act, to ensure that the Minister makes an informed decision on whether or not to approve the action.

If the Commonwealth has signed a bilateral agreement with a State or Territory in which the action is to be carried out, the State or Territory will assess the action under the terms of that agreement. Similarly, the environmental assessment may be carried out by another Commonwealth agency if a ministerial Declaration has been signed with that agency. If no bilateral agreement or Ministerial declaration is in place, the assessment may nonetheless be carried out by a State or Territory under an accredited assessment process.

There is currently a Bilateral Agreement between the Commonwealth and New South Wales governments. The Bilateral Agreement applies to actions that the Commonwealth Environment Minister has determined as controlled actions under the EPBC Act in relation to MNES matters of national environmental significance [DoP, 2007 #2469]. Under the Bilateral Agreement, there is no longer a need for parallel assessments by the Commonwealth and the NSW government for controlled actions, and projects which required approval from both the State and the Commonwealth are only required to be assessed once by a State agency or council [DoP, 2007 #2469]. The same assessment is then used by both the State and the Connomwealth to determine whether to approve the proposal. The Bilateral Agreement only provides for the accreditation of the specified state assessment processes to meet the assessment requirements of the EPBC Act. The Commonwealth will still need to issue a separate approval for the development based on the state assessment and approval conditions [DoP, 2007 #2469].

If none of these assessment processes are applicable, the Commonwealth will carry out the assessment using one of the following assessment approaches:

- Preliminary documentation.
- Public environment report.
- Environmental impact statement (EIS).
- Public inquiry.

The proponent, or the person proposing to take the action, will be asked to supply preliminary information on the impacts of the proposed action in order to help the Minister select an appropriate assessment approach.

3.2 Threatened Species Conservation Act 1995 (NSW) and Environmental Planning and Assessment Act 1979 (NSW)

One objective of the EP&A Act is to encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats. A second objective is to encourage the principles of ecologically sustainable development, including the precautionary principle as defined under the *Protection of the Environment Administration Act* 1991. The TSC Act protects all threatened plants and animals native to NSW (with the exception of fish and marine plants). It provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species.

If a planned development or activity will have an impact on a threatened species, this must be taken into account in the development approval process. If the impact is likely to be significant, a Species Impact Statement must be prepared and the Director-General of the DECC must agree to the development approval. In some cases, the Minister for the Environment, Water, Heritage and the Arts will also need to be consulted.

PART 3A provisions of EP&A Act

The EP&A Act was amended in June 2005 to reform the land-use planning and development assessment and approval system, particularly as it relates to major infrastructure and other significant development. Part 3A, the Act provides a single assessment and approval regime for all major infrastructure and other projects previously undertaken under Part 4 and/or Division 4 of Part 5 of the EP&A Act. Part 3A applies to major State government infrastructure projects, development that previously was classified as State significant development and other projects, plans or programs declared by the Minister for Planning.

Provisions have been made in the Act for:

- Independent Hearings and Panel Assessments to strengthen the assessment process;
- concept plans for complex projects, plans or programs so that the overall provisions can be evaluated prior to consideration of the details of the project(s). This provides for matters such as the suitability of the site/route and environmental issues to be resolved up-front and provides for the simplification of subsequent approvals where environmental impacts can be avoided or minimised; and,
- the Minister to declare projects to be ‘critical infrastructure projects’. Prior to making such a declaration, a preliminary risk assessment will be required to

consider the financial, economic, social and environmental risks of declaring the project a critical infrastructure project. These projects only require a concept approval and there are no appeal rights except if initiated by the Minister.

3.3 Water Management Act 2000 and Rivers and Foreshores Improvement Act 1948 (NSW)

The *Water Management Act 2000* (WM Act) provides for the integrated and sustainable management of the State's waters, including those provisions previously included in the *Rivers and Foreshores Improvement Act 1948* (RFI Act). Whilst proclamation commenced most of the provisions of the WM Act on 1 January 2001 (NSW Government Gazette No. 168, December 2000), matters relating to licences and approvals still continue to be dealt with by the RFI Act and the *Water Act* 1912. The Department of Natural Resources is currently developing the administrative procedures to operate the approvals provisions of the WM Act; however, it is not known when these provisions will commence.

While the RFI Act allows the carrying out of works to remove obstructions from and improve rivers and foreshores and to prevent erosion of lands by tidal and non-tidal water, under Part 3A, Section 22B a person must not:

- Make an excavation on, in or under protected land (land within 40m from top of bank);
- Remove material from protected land;
- Do anything which obstructs, or detrimentally affects, the flow of protected waters, or which is likely to do so unless the person is authorised to do so by a permit.

When assessing developments that require a Part 3A permit, the Department Natural Resources (DNR) considers whether the proposed upgrade is consistent with State Government policy including the NSW State Rivers and Estuaries Policy. Conditions of consent for a Part 3A permit, may as a result, include the establishment of a native vegetation riparian zone along a waterway. Given State Government policy, it is unlikely that a Part 3A permit would be issued for works that degrade watercourses and their environment; as it is DNR's aim that:

- An adequate native vegetation riparian zone (minimum 20 m) be kept or established on either side of any waterway or wetland,
- On-line or instream water quality structures such as water quality ponds, trash racks and gross pollutant traps are strongly discouraged as they affect the continuity and corridor function of waterways and result in loss of riparian vegetation and habitat, and that
- Channelisation, piping and/or relocation of streams and the construction of on-line or instream structures and culverts for waterway road crossing are discouraged.

Under the RFI Act, works in or under protected land that occur within a RTA Road Reserve do not require a Part 3A permit, however, should works occur outside the road reserve, a Part 3A permit may be required. While the RFI Act does not apply to land within the road reserve, it is recommended that the principles of the Act (as described above) and State Government policies are followed in order to ensure that waterways within the study area do not become degraded as a result of the preferred highway upgrade and operation.

Under Part 3A of the EP&A Act, permits under Part 3A of the RFI Act and/or the section 91 of the Water Management Act are not required for an approved project. However, as a matter of environmental impact assessment, it is considered appropriate to have regard to the principles of the Water Management Act.

3.4 State Environmental Planning Policy 44 – Koala Habitat Protection (NSW)

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas, ensuring a permanent free-living population over their present range and attempting to reverse the current trend of Koala population decline:

a) By requiring the preparation of plans of management before development consent can be granted in relation to areas of core Koala habitat;

b) By encouraging the identification of areas of core Koala habitat; and

c) By encouraging the inclusion of areas of core Koala habitat in environment protection zones.

Under this policy the distinction is made between 'potential' and 'core' Koala habitat.

"Potential Koala habitat" means areas of native vegetation where the trees of the types listed in Schedule 2 of the Policy constitute at least 15 of the total number of trees in the upper or lower strata of the tree component.

"Core Koala habitat" means an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

SEPP 44 applies to land within local government areas (LGA's) listed in SEPP 44, Schedule 1 (including both Byron and Ballina LGA's) for which a development application has been made (SEPP 44, Section 6) and Council is the determining authority. SEPP 44 does not apply to land dedicated or reserved under the National Parks and Wildlife Act 1974 or to land dedicated under the

Forestry Act 1916 as State Forest or flora reserve (SEPP 44, Section 5). Nor does it apply to land where Council is not the determining authority. Thus, in instances where State agencies such as the RTA undertake Part 3a activities under the EP&A Act (as for the present development), SEPP 44 does not apply, even if an EIS is required.

Government departments, including the RTA, are not legally required to consider the provisions of SEPP 44, based on consulatation between Biosis Research, the RTA and Arup it has been agreed that a similar approach to assessing Koala habitat as that described under SEPP 44 should be undertaken. This will help ensure the longer-term survival of Koalas, and proper conservation and management of areas of natural vegetation providing habitat for Koalas in the vicinity of the study area.

3.5 State Environmental Planning Policy 14 - Coastal Wetlands

The aim of SEPP 14 is the preservation and protection of coastal wetlands in the environmental and economic interests of the State (Department of Planning Circular No. B10). The policy lists clearing, draining or filling and the constructing of a levee on gazetted coastal wetlands as 'designated developments'. Such developments proposed on gazetted wetlands require development consent from the relevant Council and the concurrence of the Director-General of Planning. When considering whether to grant concurrence, the Director-General takes into account (along with other considerations):

- The environmental effects of the proposed upgrade,
- Whether adequate safeguards and rehabilitation measures have been or will be put in place,
- Whether consideration has been given to any feasible alternatives, and
- Any surrounding wetlands affected by the proposed upgrade and appropriateness of imposing conditions requiring the carrying out of works to preserve or enhance the value of those surrounding wetlands.

There are no SEPP 14 wetlands within the study area. However, there are numerous SEPP 14 wetlands located immediately east of the study area, including Cumbebin Swamp, Newrybar Swamp and Ballina Nature Reserve which may be indirectly impacted by the proposed upgrade. Although this is unlikely given none of the creeks/drainage lines likely to be impacted within the study area drain into any of these SEPP 14 wetlands.

4.0 RESULTS

4.1 Flora

For the flora assessment, patches of native vegetation occurring within the study area have been surveyed. Though all patches of treed vegetation in the study area have been surveyed at some stage during the project, not every patch could be surveyed in detail during the recent (November 2006) surveys due to access restrictions. Where patches could not be accessed during the most recent surveys, data from previous surveys (November 2004/2005) has been used. It should be noted that these surveys were undertaken using the same methodology.

4.1.1 Plant Communities

Plant communities recorded within the study area include Lowland Rainforest, Camphor Laurel and plantations (Figure 3). These plant communities are described in more detail below.

General Descriptions

Lowland Rainforest

Location: small fragmented stands scattered throughout the study area, within a mostly cleared landscape.

Area: Approximately 5.6 ha of Lowland Rainforest in the study area, with 2 ha directly impacted and 3.6 ha indirectly impacted.

Description/Structure: The upper canopy reaches maximum height of approximately 25 m and a projective foliage cover of up to 80 %. The midstorey reaches a maximum height of approximately 10 m, with density varying across patches depending on level of disturbance to the upper canopy. The shrub layer and understorey are generally sparse, reaching a maximum height of approximately 2 m and 1 m respectively.

Canopy trees: *Alphitonia petrei, Cinnamomum camphora, Cupaniopsis anacardioides, Elaeocarpus grandis, Ficus coronata, F. macrophylla, Guioa semiglauca, Pittosporum undulatum, Syzygium moorei* and *Toona cilliana.*

Midstorey: *Acacia maidenii, Caldcluvia paniculosa, Cinnamomum camphora, Diploglottis australis, Ficus fraseri, Guioa semiglauca, Jagera pseudorhus* var. *pseudorhus, Mallotus philippensis, Pittosporum undulatum, Toona cilliana, Wilkiea huegeliana* and *Wilkiea macrophylla.*

Shrubs: *Coprosma quadrifida, Ligustrum* spp., *Maclura cochinchinensi,*

Melastoma affine, Omalanthus populifolius, Pilidiostigma glabrum and *Pittosporum undulatum,*

Ground layer: *Adiantum hispidulum, Ageratina adenophora, Ageratina riparia, Alocasia brisbanensis, Cirsium vulgare, Commelinia cyanea, Hypolepis muelleri, Oplismenus aemulus* and *Paspalum dilatatum.*

Vines: *Geitonoplesium cymosum, Pandorea pandorana* ssp. *pandorana, Passiflora herbertiana* and *Tinospora tinosporoides.*

Condition/Disturbances: The patches of Lowland Rainforest in the study area are considered to be in moderate to poor condition due to the small size and fragmentation of the patches and the resulting altered structure and reduced native species diversity. The patches are highly modified due to the impacts of adjoining land uses, though many of the patches show signs of natural resilience. There are also a number of revegetation areas, where the natural soil profile has been highly disturbed and natural regeneration is very limited.

Habitat for rare or threatened flora: Threatened species recorded in Lowland Rainforest in the study area include *Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei* and *Tinospora tinosporoides.* In addition, *Archidendron muellerianum* was recorded in the Lowland Rainforest in the study area and is listed as a ROTAP species, with a Risk Code of 3RCa (see Appendix 2 for explanation of codes).

Lowland Rainforest also provides potential habitat for a number of species listed on the TSC Act and/or the EPBC Act (Appendix 4), including *Amorphospermum whitei, Archidendron hendersonii, Arthraxon hispidus, Baloghia marmorata, Bosistoa selwynii, Bosistoa transversa, Davidsonia jerseyana, Davidsonia johnsonii, Desmodium acanthocladum, Diospyros mabacea, Drynaria rigidula, Elaeocarpus williamsianus, Endiandra floydii, Endiandra hayesii, Endiandra muelleri* ssp. *bracteata, Floydia praealta, Gossia fragrantissima, Grevillea hilliana, Hibbertia hexandra, Hicksbeachia pinnatifolia, Isoglossa eranthemoides, Marsdenia longiloba, Melicope vitiflora, Ochrosia moorei, Owenia cepiodora, Phaius australis, Phyllanthus microcladus, Randia moorei, Senna acclinis, Sophora fraseri, Syzygium hodgkinsoniae* and *Xylosma terrae-reginae*.

Constraint: All patches of Lowland Rainforest within the study area are given a High constraint despite their condition, as Lowland Rainforest is listed as an Endangered Ecological Community on the TSC Act.

Dominated by Camphor Laurel

Location: small fragmented stands scattered throughout the study area.

Area: Approximately 15.2 ha of Camphor Laurel in the study area, with 5.7 ha directly impacted and 9.5 ha indirectly impacted.

Description/Structure: The upper canopy varies in height depending on the age of the trees, ranging from 20 to 25 m in older stands. The projective foliage cover ranges from 30% to 80% depending on density of growth and age of the trees. The midstorey and understorey are variable depending on the density of the canopy.

Canopy trees: *Cinnamomum camphora,* with *Pittosporum undulatum* and occasional rainforest species.

Midstorey: Saplings of *Cinamomum camphora* dominated the midstorey, out competing native species. Other species recorded in the midstorey included *Guioa semiglauca* and *Pittosporum undulatum.*

Shrubs: *Cinnamomum camphora, Pittosporum undulatum* and *Lantana camara* and occasional scattered rainforest species such as *Neotitzea dealbata, Pilidiostigma glabrum, Mallotus philippensis* and *Toona ciliata.*

Ground layer: Seedlings of *Cinamomum camphora* dominated the understorey, out competing native species. Other species recorded in this ground layer included *Ageratina riparia, Bidens pilosa, Ligustrum sinense, Paspalum wettsteinii* and *Pennisetum clandestinum.*

Vines: *Rubus rosifolius var. rosifolius, Marsdenia rostrata.*

Condition/Disturbances: The patches of Camphor Laurel were considered to be in either poor condition or an unnatural landscape due to the lack of native species diversity and structure. It is unlikely that these patches would regenerate to Lowland Rainforest given the density of *Cinnamomum camphora* present in each structural layer and the lack of regeneration of native species. These areas were not considered to be representative of a native plant community.

Habitat for rare or threatened flora: Threatened species recorded in Camphor Laurel patches in the study area include *Diploglottis campbellii, Macadamia tetraphylla* and *Tinospora tinosporoides,* and the ROTAP species *Archidendron muellerianum.*

Constraint: Patches of Camphor Laurel in the study area have generally been given a low constraint, with the exception of patches that form part of a corridor (including riparian corridors and proposed wildlife corridors) or where a threatened species has been recorded within the patch. In these cases the constraint level has been upgraded to medium.

Plantations

Plantations included roadside plantings and garden areas, but did not include Macadamia plantations. As a conservative approach, where plantations had a dominance of local native rainforest species, these were considered to be patches of Lowland Rainforest. Where these patches supported a variety of local and non-local native species and exotics, they were considered to be plantations. Plantations have been given a low constraint, with the exception of areas where threatened species have been recorded, where the constraint level has been upgraded to medium.

Area: Approximately 3.2 ha of Plantations in the study area, with 2.7 ha directly impacted and 0.5 ha indirectly impacted.

Plant communities within the study area

Ewingsdale/St Helena section (including tunnel)

Three patches of Lowland Rainforest will be directly or indirectly impacted by the proposed upgrade in this section (Figure 3), all of which were considered to be in poor condition due to their small size, reduced species and structural diversity and impacts from adjoining land uses. Three patches of Camphor Laurel will be directly or indirectly impacted by the proposed upgrade in this section, these patches were all considered to be a low constraint, due to the low species diversity, small size and lack of resilience. One plantation that may be indirectly impacted was recorded in this section, which was given a high constraint due to it being within a proposed regional corridor and supporting threatened flora and fauna (*Tinospora tinosporoides* and Koala).

These calculations do not include the patches of vegetation which occur within the tunnel section of the proposed upgrade, which are not likely to be impacted.

Patches of vegetation surveyed in detail are described below:

Patch 1 (3.7 ha): A number of small patches of regrowth Lowland Rainforest were surrounded by exotic pasture and not fenced from grazing activities. These patches were considered to be in poor condition with little resilience. Canopy species included *Mallotus philippensis, Guioa semiglauca, Ficus coronata, F. macrophylla, Jagera pseudorhus var. pseudorhus*; and midstorey species included *Aphananthe philippinensis, Maclura cochinchinensis.* The understorey supported a number of native ferns and grasses such as *Adiantum hispidulum var. hispidulum, Blechnum indicum, Christella dentata, Hypolepis muelleri* and *Oplismenus aemulus*. Exotic pasture grasses such as *Paspalum dilatatum* and *Pennisetmum clandestinum* and weeds such as *Cirsium vulgare* and *Gompholobium fruticosum* were recorded in the surrounding cleared paddock and invading the small patches. No individuals of these species would be

removed in this section.

Threatened species recorded in this area included *Syzygium moorei* and *Tinospora tinosporoides.* Approximately 17 mature remnant trees of *Syzygium moorei* were recorded as isolated trees in a cleared paddock (Figure 3). *Tinospora tinosporoides* was recorded growing amongst the native shrubs in the patch of regrowth Lowland Rainforest (Figure 3).

Patch 2 (3 ha): A patch of vegetation dominated by *Cinnamomum camphora* to a height of 25 m and a projective foliage cover of 70 % was recorded in this area. The midstorey and understorey were dominated by *Cinnamomum camphora,* with numerous seedlings and saplings out competing native species. Other exotic species in this area included *Ligustrum sinense, Ageratina riparia* and *Bidens pillosa.* Some regrowth of native rainforest species were also recorded in this area, including small trees and shrubs such as *Actephila lindleyi, Arytera distylis, Cyathea australis, Eupomatia bennettii, Ficus coronata, Guioa semiglauca* and *Mallotus philippensis;* and ferns such as *Adiantum hispidulum* var. *hispidulum* and *Christella dentata*.

Despite the presence of native rainforest species in this patch, the density and dominance of *Cinnamomum camphora* was so great that this patch is not considered to be Lowland Rainforest, nor it is considered likely to naturally regenerate to Lowland Rainforest. This patch was considered to be in poor condition due to the low native species diversity and dominance of exotic species.

Two ROTAP species were recorded in this patch: *Archidendron muellerianum* (Risk Code 3RCa) and *Quassia* sp. 'Mt Nardi' (Floyd 1198) (Risk Code 3RC-) (See Appendix 2 for explanation ofROTAP Risk Codes).

Patch 3 (3.3 ha): Patch 3 supported a small patch of Lowland Rainforest to the north of the Casino - Murwillumbah Railway Line, adjoining a larger area of Camphor Laurel supporting dense *Cinnamomum camphora*. This patch was considered to be in Poor condition due to the relatively low native species diversity and altered structure.

Dominant species in the canopy included native species *Ficus coronata, Guioa semiglauca, Mallotus philippensis* and *Pittosporum undulatum* and the exotic *Cinnamomum camphora.* The midstorey and shrub layer was relatively intact in places and supported native species such as *Actephila lindleyi, Arytera distylis, Caldcluvia paniculosa, Coprosma quadrifida, Cordyline rubra, Diploglottis australis, Neolitsea dealbata* and *Pilidiostigma glabrum;* with the exotic species *Lugustrum lucidum* and *L. sinense* also occurring. The understorey supported a diversity of ferns such as *Adiantum hispidulum* var. *hispidulum, Calochlaena dubia, Christella dentata, Gleichenia dicarpa, Hypolepis muelleri* and *Lastreopsis decomposita*, with exotic species *Ageratina adenophora* and *A.*

riparia. Vines such as *Austrosteenisia glabristyla, Carronia multisepalea, Cissus hypoglauca* and *Smilax australis* were also recorded in this patch.

No threatened species were recorded in this patch, however, this patch does provide potential habitat for a number of threatened species.

Bangalow/Newrybar section

Four patches of Lowland Rainforest would be directly or indirectly impacted in this section of the study area (Figure 3), two of which were revegetation projects and consisted of stands of even aged rainforest trees, one of which consisted of planted rainforest trees in a garden landscape surrounding a house and one which was a regrowth patch of Lowland Rainforest. All these patches were given a high constraint despite being in poor condition, due to their small size and lack of structural and species diversity. Five patches of Camphor Laurel would be directly or indirectly impacted by the proposed upgrade in this section, all of which were given a low constraint. These patches exist as small scattered patches with very low native species diversity and no natural resilience due to the ongoing impacts from adjoining land uses. One plantation was also recorded in the area of impact in this section, which was given a low constraint.

The patches surveyed in detail are described below.

Patch 4 (4.8 ha): A small patch of Camphor Laurel was recorded to the south of the Casino - Murwillumbak Railway Line. This patch was part of the riparian corridor following Byron Creek and, as such, was given a medium constraint despite the low native species diversity. The vegetation in this patch was dominated by *Cinnamomum camphora* in all structural layers, with some regrowth of native species such as *Guioa semiglauca* and *Neolitsea dealbata*.

Despite the regrowth of some native species in the understorey of this patch, due to the dominance and density of *Cinnamomum camphora,* it is considered unlikely that this patch would naturally regenerate to Lowland Rainforest.

Patch 5 (1.7 ha): This area supported a revegetated patch of Lowland Rainforest adjoining the Pacific Highway. Natural structure was absent from this patch, with all the plantings reaching a height of approximately 10 m and other structural layers essentially absent. There was limited recruitment of native seedlings beneath the dense planted canopy, with approximately 60 % coverage of leaf litter.

Planted species in this patch included *Acmena smithii, Archontophoenix cunninghamiana, Caldcluvia paniculosa, Commersonia bartramia, Cupaniopsis anacardioides, Elaeocarpus grandis, Flindersia bennettiana, Guioa semiglauca, Jagera pseudorhus var. pseudorhus, Melastoma affine, Melicope elleryana* and *Toona ciliata.* Non local native species such as *Grevillea robusta* and the exotic

Jacaranda mimosifolia were also planted in this area. Native species regenerating in the understorey included *Hypolepis muelleri* and *Microlaena stipoides var. stipoides.*

Exotic species recorded in the cleared paddock surrounding this patch included *Ageratina riparia, Ambrosia tenuifolia, Axonopus affinis, Cinnamomum camphoraa. Ligustrum spp., Ochna serrulata, Paspalum dilatatum* and *Pennisetum clandestinum.*

Syzygium moorei was recorded along the roadside within the landscaping area and is likely to be a planted specimen. In addition, the ROTAP species *Archidendron muellerianum* was also planted in this patch (Figure 3).

Patch 6 (1.6 ha): A small patch of Lowland Rainforest in moderate condition was recorded adjacent to the Pacific Highway south of Bangalow. The structure of this patch was relatively intact, with a relatively high diversity of native species in all structural layers and a low density of weeds despite being impacted by grazing, rubbish dumping and erosion.

This patch supported a diversity of rainforest trees in the canopy such as *Alphitonia petriei, Archontophoenix cunninghamiana, Commersonia bartramia, Ficus fraseri, Guioa semiglauca, Toona ciliata* and the exotic *Cinnamomum camphora.* The midstorey and shrub layer were relatively diverse, supporting species such as *Cryptocarya glaucescens, Cryptocarya obovata, Diploglottis australis, Eupomatia laurina, Flindersia australis, Maclura cochinchinensis, Mallotus philippensis* and *Wilkiea* spp. The understorey supported ferns and grasses such as *Adiantum hispidulum* var. *hispidulum, Hypolepis muelleri* and *Microlaena stipoides.* Vines such as *Austrosteenisia glabristyla, Carronia multisepalea* and *Tinospora tinosporoides* were also recorded in this patch.

The exotic species *Bidens pilosa, Cirsium vulgare, Conyza albida, Crassocephalum crepidioides* and *Solanum* spp. were recorded along the edges of this patch, spreading from the adjoining cleared paddock.

The threatened species *Tinospora tinosporoides* was recorded in this patch.

Patch 7 (9.9 ha): A patch of vegetation dominated by *Cinnamomum camphora* in all structural layers, with *Lantana camara, Ligustrum sinense* and *Pittosporum undulatum* also occurring. This patch is considered to be a low constraint due to the lack of native species diversity and lack of resilience. (Note: this patch was not surveyed in detail during the November 2006 surveys due to access restrictions).

Patch 8 (0.9 ha): This area consists of a patch of planted trees around a house. This patch was surveyed from the roadside.

Rainforest trees planted in this area included *Ceratopetalum apetalum, Cupaniopsis anacardioides, Guioa semiglauca* and *Mallotus philippensis.* Non-rainforest trees were also planted in this area, including *Eucalyptus pilularis, E. saligna, E. microcorys* and the exotic *Pinus nigra* var. *corsicana. Cinnamomum camphoraa* was also recorded in this patch.

Patch 9 (3.1 ha): This area consisted of a stand of immature *Eucalyptus* trees planted in straight rows. Small trees of *Acacia elata* were also planted in this area and *Cinnamomum camphora, Pittosporum undulatum* and *Ligustrum* spp. were also recorded growing along the roadside. The understorey supported exotic grasses and herbaceous species. This area is not considered to support a native plant community due to the high level of disturbance and lack of native species. As such, this area was given a low constraint.

Patch 10 (0.8 ha): This area consist of a stand of planted rainforest trees to a height of approximately 20 m. Natural structure was absent from this patch, with all the plantings reaching a height of approximately 20 m and other structural layers essentially absent. The adjoining land was cleared, with landscaped garden areas and dams.

Species planted in this patch included *Alphitonia petriei, Archontophoenix cunninghamiana, Diploglottis australis, Elaeocarpus grandis, Guioa semiglauca, Syzygium moorei* and *Toona ciliata*. Non local native species such as *Grevillea robusta* were also planted in this patch. Other structural layers were essentially absent, with the exception of regrowth of some native tree species such as *Archontophoenix cunninghamiana* and *Guioa semiglauca* in the understorey amongst the dense leaf litter.

The threatened species *Diploglottis campbellii* and *Syzygium moorei* were planted in this patch. Two specimens of *Diploglottis campbellii* and eight specimens of *Syzygium moorei* were recorded.

Emigrant Creek/Knockrow section

Five patches of Lowland Rainforest would be impacted by the proposed upgrade in this section, one of which consisted of planted trees in a garden landscape around a house and four of which were regrowth stands of Lowland Rainforest in varying condition. Patches of vegetation surveyed in detail are described below.

Patch 11 (1 ha): A small patch of rainforest trees planted around a house was recorded approximately 400 m north of Carney Place to the west of the Pacific Highway. This area was surveyed from the roadside.

Trees planted in this area included local natives *Archontophoenix cunninghamiana, Callistemon salignus, Ficus macrophylla* and *Toona ciliata* and non local native *Grevillea robusta*. Exotic trees also recorded in this area

included *Araucaria heterophylla, Cinnamomum camphoraa, Jacaranda mimosifolia* and *Pinus nigra* var. *corsicana.*

Patch 12(2.3ha): A small patch of regrowth Lowland Rainforest was recorded in this area. The patch was reasonably diverse, with a high proportion of native species and high structural diversity. A patch of dense *Cinnamomum camphora* bordered this patch to the west. (Note: this patch was not surveyed in detail during the November 2006 surveys due to access restrictions).

Threatened species recorded in the vicinity of this patch included *Syzygium moorei* and *Diploglottis campbellii. Macadamia tetraphylla* was also recorded nearby, close to the house.

Patch 13 (2.6 ha): This patch of Lowland Rainforest is part of a riparian corridor along Emigrant Creek and varied in condition from poor to moderate. The eastern edge of the patch was in poor condition, impacted from adjoining land uses and by weed invasion. This area consists of a thinned canopy layer, with regrowth of native species such as *Toona ciliata* and *Acacia maidenii* and exotic species *Cinnamomum camphora* and *Lantana camara* also occurring. The understorey was dominated by herbaceous weeds such as *Ageratina riparia, Ageratina adenophora* and *Bidens pilosa.*

Away from the disturbed eastern edge, the patch improved in condition, with a relatively intact tree canopy and higher species and structural diversity. Additional species recorded in this area included *Ceratopetalum apetalum, Diploglottis australis, Maclura cochinchinensis, Pilidiostigma glabrum* and *Wilkiea macrophylla* occurring in the canopy, midstorey and shrub layer.

Two threatened species were recorded in this patch of Lowland Rainforest, *Macadamia tetraphylla* and *Tinospora tinosporoides.* Approximately ten mature trees and eight seedlings of *Macadamia tetraphylla* were recorded in this patch away from the disturbed edge. *Tinospora tinospodoides* was recorded growing in the canopy of the mature *Macadamia tetraphylla* trees.

Patch 14 (4.6 ha): This patch of Lowland Rainforest is considered to be in poor condition, with reduced structural and species diversity due to adjoining land uses. In particular, cattle are not prevented from accessing the patch, resulting in erosion and grazing and trampling of understorey species. The landowner has attempted to poison out existing *Cinnamomum camphora* with some success (J. Balzer, personal communication, 23 November 2005). The canopy supported *Guioa semiglauca, Ficus cornata* and *Cinnamomum camphora;* and the midstorey supported *Guioa semiglauca, Jagera pseudorhus* var. *pseudorhus, Mallotus philippensis* and *Pittosporum undulatum.* The understorey was sparse, supporting shrubs *Cryptocarya laevigata, Maclura cochinchinensis* and *Lantana camara* and ferns *Adiantum hispidulum* var. *hispidulum* and *A. formosum.*

Threatened species recorded in this patch included *Tinospora tinosporoides* growing in the understorey and *Syzygium moorei*, which had been planted in a garden area adjoining the Pacific Highway.

Patch 15 (8.5 ha): This patch was dominated by the weed species *Cinnamomum camphora* (greater than 80%), *Lantana camara* and *Pennisetum clandestinum*. There were also a few scattered rainforest trees and shrubs present. Given the dominance of *Cinnamomum camphora* and the lack of native species diversity, this patch is considered to be an Unnatural Landscape and was classified as Camphor Laurel rather than as Lowland Rainforest.

4.1.2 Endangered Ecological Communities

Table 5 provides a list of the EEC's occurring within the NSW North Coast Bioregion and whether suitable habitat occurs within the study area. One Endangered Ecological Community (EEC) listed on the TSC Act, Lowland Rainforest, was recorded within the study area.

Table 5: Endangered Ecological Communities listed on the TSC Act that occur in the NSW North Coast Bioregion

Endangered Ecological Community	Habitat requirements	Habitat in study area
Byron Bay Dwarf Graminoid Clay Heath Community	Gently sloping clay ridges of low relief, within the Byron Bay Council area.	No. No sloping clay ridges of low relief in the study area.
Coastal Saltmarsh	Intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast.	No. Study area not in vicinity of estuary or lagoon.
Freshwater Wetlands on Coastal Floodplains	Periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, lagoons and lakes of coastal floodplains. They generally occur below 20 m elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions.	No. Study area does not occur on the coastal floodplain. Has been previously recorded to the east of the study area, in the Midgen Flat area.
Littoral Rainforest	Most stands of Littoral Rainforest occur within 2 km of the sea, but may occasionally be found further inland, but within reach of maritime influence.	No. study area approximately 7 km from sea and not within reach of maritime influence.
Lowland Rainforest on Floodplain	This community occurs on fertile soils in lowland river valleys. Less than 1000 ha remain in NSW and remaining stands are small and isolated.	No. Study area does not occur on the coastal floodplain. Has been previously recorded to the northeast of the study area, in the Midgen Flat area.

Endangered Ecological Community	Habitat requirements	Habitat in study area
Lowland Rainforest	Associated with a range of high-nutrient geological substrates, notably basalts and fine-grained sedimentary rocks, on coastal plains and plateau, footslopes and foothills. In the north of its range, Lowland Rainforest is found up to 600 m above sea level, but in the Sydney Basin bioregion it is limited to elevations below 350 m.	Yes. Has been recorded along and west of the Main Coast Range within and in proximity to the study area.
Sub-tropical Coastal Floodplain Forest	Associated with clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces of coastal floodplains. It generally occurs below 50 m, but may occur on localised river flats up to 250 m elevation in the NSW North Coast bioregion.	No. Study area not on coastal floodplain.
Swamp Sclerophyll Forest on Coastal Floodplains	Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines of coastal floodplains. It generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains.	No. Study area does not occur on the coastal floodplain. Has been previously recorded on the floodplains to the southeast of the study area, mostly south of Midgen Flat Road.

No Endangered Ecological Communities listed on the EPBC Act have previously been recorded within 10 km of the study area (search of DEWHA Online Database, 11th February 2008). No Endangered Ecological Communities listed on the EPBC Act occur in the study area.

Figure 3 shows the constraints mapping based on the classification of vegetation patches described in Section 4.2.1 above. Although the study area contains numerous patches of vegetation, many of these patches consist predominantly of Camphor Laurel and as such, are of relatively low conservation value, and a low constraint to the proposed upgrade. As many of the patches of Lowland Rainforest are infested with Camphor Laurel and this community is listed as an EEC, it is important to define at what level of Camphor Laurel infestation that this community no longer represents the definition in the scientific committee's final determination. After consultation with DECC (Andrew Hugget, *pers. comm*., 13 January 2006) it was determined for the purposes of this assessment that Lowland Rainforest would no longer meet the EEC definition (as defined by the preliminary determination, which has now been finalised) when it has greater than moderate Camphor Laurel infestation (i.e. greater than 80 % Camphor Laurel). This definition has been used in section 4.2.1 above in determining

which patches have been classified as Lowland Rainforest or Camphor Laurel. Apart from patches of Camphor Laurel and plantations, all native endemic vegetation within the study area is an EEC.

4.1.3 Groundwater Dependant Ecosystems

The Bureau of Rural Sciences Australia (Brodie and Green 2002) identified and mapped the groundwater dependant ecosystems on the Alstonville Plateau, which are described as:

Wetlands – aquatic communities and fringing vegetation dependent on groundwater fed lakes and wetlands. These are lands permanently or temporarily under water or water logged, and include groundwater springs and seepage areas.

River base flow systems – aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow. Groundwater may be a significant contributor to flows in coastal streams supporting riparian forests, "sedgelands" and grasslands, as well as in-stream flora and fauna.

Terrestrial vegetation – vegetation communities and dependent fauna that have seasonal or episodic dependence on groundwater. These include trees and shrubs that require the water table to be at least episodically or periodically within their root zone.

Groundwater dependant ecosystems are least likely to be found on the hill slopes, as the hill slopes are mostly grazing land and groundwater dependant ecosystems are more likely to be found closer to creeks. Native plant communities recorded within the study area that are likely to be at least partly groundwater dependant include rainforest.

The outcome of predictive modelling carried out for the groundwater impacts study (Golder associates 2008), suggests that impacts to groundwater dependant ecosystems in the hyporheic zone[4] are likely in the case of cuts which penetrate into the water table zone upgradient of springs and creeks.

Groundwater dependant ecosystems within and adjacent to the creek alignments may be affected whenever the water flow in the creek is lessened or the shallow groundwater table lowered (Golder associates 2008). From Table 1 in Golder Associates (2008), there are two such cuts that could impact on groundwater dependant ecosystems (rainforest) within the study area in this way, one at the

[4] The hyporheic zone is a region beneath and lateral to a stream bed, where there is mixing of shallow groundwater and surface water (Golder Associates 2008). The flow dynamics and behaviour in this zone (termed hyporheic flow) is recognized to be important for surface water/groundwater interactions, as well as fish spawning, among other processes (Golder Associates 2008).

tunnel in the St Helena ridge and the other at chainage 15405-15900, in Tinderbox Creek valley. Neither of these potentially impacted groundwater dependant ecosystems corresponds to the numbered patches that were surveyed as part of the current assessment. From the Figure provided in Appendix C of Golder Associates (2008), the closest patch of Lowland Rainforest to the tunnel at St Helena Ridge is a thin strip of fragmented Lowland Rainforest occurring along the ridgline and adjoining St Helena Road. The closest Lowland Rainforest patch to the cut at chainage 15405-15900 is a very small and isolated patch of Lowland Rainforest within the cleared paddock, supporting a record of *Syzygium moorei*.

It is considered that Lowland Rainforest is unlikely to be significantly impacted by changes in hydrology as a result of the proposed upgrade, due to the high level of rainfall in the study area. However, monitoring has been proposed to mitigate uncertainty in predictions of groundwater behaviour (Golder Associates 2008). As part of this monitoring, the health of any groundwater dependant ecosytems would be assessed (Golder associates 2008). The objective of the monitoring would be to obtain baseline groundwater data, monitor the effectivness of mitigation measures and monitor impacts as a result of construction (Golder associates 2008).

4.1.4 Plant Species

A total of 196 species of vascular plant were recorded from the study area, comprising 140 (71%) indigenous species and 56 (29%) introduced species (Appendix 3).

Five species listed as noxious weeds in the Far North Coast County Council (including Ballina and Byron Bay LGA's) were recorded in the study area: *Ageratina adenophora* (Class 4), *Ageratina riparia* (Class 4), *Baccharis halimifolia* (Class 3), *Cinnamomum camphora* (Class 4) and *Lantana camara* (Class 4 and 5). The legal requirements of these Classes of noxious weed are as follows:

- Class 3 - the plant must be fully and continuously suppressed and destroyed.
- Class 4 - the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
- Class 5 - The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

4.1.5 Significant Plant Species

Forty-nine threatened plant species listed on the TSC Act (Figure 4) and/or the EPBC Act, have been recorded or have potential habitat within the Locaility (DECC Atlas of NSW Wildlife, DEW's EPBC Online Database; Appendix 4). Four threatened species listed on the TSC Act and EPBC Act have been previously recorded within the study area: *Diploglottis campbellii, Macadamia tetraphylla*, *Syzygium moorei* and *Tinospora tinosporoides* (Figure 3). These records were confirmed during the field surveys (November 2006), and these species are discussed in more detail below.

In addition, two ROTAP species (Briggs and Leigh 1996) were recorded in the study area: *Archidendron muellerianum* and *Quassia* sp. 'Mt Nardi (Figure 3). These two ROTAP species are not listed on the TSC or EPBC Act and, as such, are not required to be considered further.

Of the total of 49 threatened plant species considered in this assessment, 36 have potential habitat or have been recorded within the study area (Appendix 4). All 36 of these species are listed on the TSc Act and 24 of the species are listed on the EPBC Act (Appendix 4). Due to the presence of potential habitat, potential impacts of the proposed upgrade on these threatened species have been considered further (see Section 6.0).

The threatened plant species *Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei* and *Tinospora tinosporoides* are discussed in more detail below, as they were recorded in the study area during the current surveys.

Diploglottis campbellii

Diploglottis campbellii has been recorded within the study area (Figure 3), with:

- Two records in a patch of replanted Lowland Rainforest (Patch 10, Figure 2), to the immediate west of the Pacific Highway at Newrybar (Yarrenbool Place). Collectively, these records represent two planted individuals; and,
- One record immediately south-east of Patch 12 (Figure 2). This record represents one individual.

There are also an additional twenty six records of *Diploglottis campbellii* within a 10 km radius of the study area (Figure 4).

In additional to the above mentioned known habitat, potential habitat for *Diploglottis campbellii* occurs in the study area in Lowland Rainforest and patches of Camphor Laurel.

Macadamia tetraphylla

One known record of *Macadamia tetraphylla* is located within the study area.

This record represents a planted individual in a garden landscape near Patch 12. There are various other records in the general vicinity, but outside the study area. Many of these recordings are in close proximity to commercial Macadamia plantations (Figures 2 and 3). It should be noted that *Macadamia tetraphylla* is also used in commercial plantations, usually as a hybrid, however these have not been considered.

Potential habitat for *Macadamia tetraphylla* is considered to be within Lowland Rainforest and Camphor Laurel which were both recorded within the study area.

Syzygium moorei

There are six records of this species in the study area including (Figure 2):

- One record in Patch 1, supporting 15 mature remmant trees;
- One record within Patch 5, occurring in a patch of Lowland Rainforest along the existing Pacific Highway;
- One record to the north of Patch 7, occurring as a scattered remnant tree in a cleared landscape;
- One record within the Patch 10, which is planted within a revegetated patch of Lowland Rainforest; and,
- One record to the south-west of Patch 14, occurring as a planted tree in a garden landscape.

Syzygium moorei has also been recorded from numerous locations within a 10 km radius of the study area (Figure 4).

Potential and known habitat for this species is considered to be within Lowland Rainforest, which was recorded within the study area.

Tinospora tinosporoides

This species has previously been recorded within the study area (Figure 2), with:

- Two recordings in Patch 6, in a patch of Lowland Rainforest; and,
- One record in Patch 14, in a patch of Lowland Rainforest.

Tinospora tinosporoides has also been recorded from numerous locations within a 10 km radius of the study area (Figure 4).

Potential and known habitat for this species is considered to be within Lowland Rainforest and Camphor Laurel which was recorded within the study area.

4.1.6 Endangered Plant Populations

No endangered plant populations as listed on the TSC Act occur within a 10 kilometre radius of the study area.

4.2 Fauna

4.2.1 Terrestrial Fauna Habitats

Suitability, size and configuration of vertebrate fauna habitats broadly correlate to the structure, connectivity and quality of local and regional vegetation types. Generally, these habitats can be categorised as Rainforest, Camphor Laurel, Plantations, Riparian (including rivers, creeks, drainage lines and wetlands) and Cleared Areas. Finer scale habitat features in and near the study area include foraging resources, tree hollows, hollow logs, dams, temporary ponds and soaks. These habitats and species associations are discussed below.

Rainforest

Rainforest habitats provide a wide range of food and shelter for vertebrate fauna. This habitat has been highly disturbed and is restricted to small isolated patches of rainforest remnants within the study area. This habitat correlates to Lowland Rainforest in the vegetation mapping (Figure 2).

Typical tree species in this habitat include figs, palms, Silky Oak, Black Bean and Brush Cherry, and supply direct (foliage, nectar, exudates) and indirect (arthropods) food resources for a range of species, particularly birds and mammals. Mature trees which have the potential to support hollows (formed in stags, mature and/or senescent trees) are very limited.

The shrub vegetation and understorey is sparse reaching a maximum height of approximately 2 m and 1 m respectively. Abundant micro-habitats are present with a scattered layer of ferns, vines and grasses covering a thick layer of leaf litter, bark and fallen, hollow logs. Many invertebrates and amphibians rely on these moisture-retaining micro-habitats to over-winter or as refuge during periods of drought. Similarly, many reptiles rely on ground litter and debris for shelter and foraging.

This habitat has been previously disturbed and is subjected to ongoing disturbances including agriculture, urban/residential development and associated infrastructure (roads, cables and powerlines). The rainforest habitat is considered to be generally in Moderate condition, with the ground flora containing a high number of indigenous species; ground, log and litter layer largely intact; and a large variety of habitat and resources for a range of native fauna available.

Examples of threatened fauna that may utilise these habitats include Rose-crowned Fruit Dove *P. regina*, Masked Owl, Grey-headed Flying Fox and microchiropteran bats.

Camphor Laurel

The study area contains a number of isolated patches of vegetation dominated by Camphor Laurel with *Pittosporum undulatum* and *Lantana camara.* The shrub layer and understorey are also dominated by Camphor Laurel saplings. Although this habitat is not generally as diverse as native forest, it can provide habitat for a range of fauna. Camphor Laurel provides an important winter food source for frugivorous fauna such as the Rose-crowned Fruit Dove, Topknot Pigeon *Lopholaimus antarcticus* and White-headed Fruit Dove *Columba leucomela*. Micro-habitat features such as logs, leaf litter, ferns and vines also provide shelter and foraging habitat for a range of native fauna including birds and reptiles.

Camphor Laurel habitat is considered to be in Moderate condition, with the ground flora containing a low number of indigenous species; fragmented plant communities; ground, log and litter layer highly disturbed.

Habitat for threatened fauna: This habitat provides foraging habitat for Wompoo Fruit-Dove *Ptilinopus magnificus*, Rose-crowned Fruit-Dove, Superb Fruit-Dove *P.superbus* and Grey-headed Flying-fox.

Rivers, Creeks, Drainage Lines and Wetlands

These riparian habitats are discussed in terms of habitat for terrestrial fauna only.

Wet depressions (heath/sedgeland), creeks, drainage lines and farm dams provide optimal habitat for a range of vertebrate (amphibians, reptiles and small ground-dwelling mammals) and invertebrate species. These areas were observed, in various forms throughout the study area.

Larger creeks within the study area, such as Emigrant and Byron creeks provide habitat and resources for a range of species. The river environment includes in-stream habitats, riverbanks, riparian vegetation and associated swamps. These habitats have a range of characteristics making them attractive to fauna such as the Common Eastern Froglet *Crinia signifera* and Large-footed Myotis.

The creeklines within the study area have been previously disturbed due to agricultural, rural and residential development and associated infrastructure. They generally consist of only a narrow strip (10-20 m) of riparian vegetation through an otherwise agricultural landscape. These habitats within the study area are considered to be in Moderate condition and may provide potential habitat for a range of vertebrate species.

Cleared Areas

Some sections within or near the study area have been cleared for a range of uses including agriculture, residential properties and infrastructure easements. Despite these changes, some native species, such as Latham's Snipe *Gallinago hardwickii*, may occur within disturbed vegetation and microhabitat components of these areas. However, generally these areas would provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals and common native species tolerant of disturbance or favouring edge/ecotone habitat.

Cleared areas are considered to be in Poor condition, with the ground flora containing a low number of indigenous species; fragmented plant communities; ground, log and litter layer highly disturbed; and, few resources available for native fauna.

Plantations

A number of Macadamia, pine and eucalypt plantations occur within the study area. Although these areas generally provide few opportunities for native fauna, they do provide foraging habitat for birds and bats, in particular the Grey-headed Flying-fox which is listed as Vulnerable on Schedule 2 of the TSC Act.

Plantations are considered to be in Poor condition, with the ground flora containing a low number of indigenous species; ground, log and litter layer highly disturbed; and, few resources available for native fauna.

4.2.2 Animal Species

Sixty-eight species of vertebrate were recorded from the study area (Appendix 5) including five amphibians, two reptiles, seven mammals and 54 birds. All species recorded are native apart from the introduced Cane Toad. Five threatened species listed on the TSC Act were recorded: four mammals (Black Flying-fox, Grey-headed Flying-fox, Little Bent-wing Bat and Large-footed Myotis) and one bird species (Masked Owl). However, the Large-footed Myotis is only a probable identification based on Anabat records[5]. The Grey-headed Flying Fox is listed on both the TSC Act and the EPBC Act. Two migratory species as listed under the EPBC Act were recorded in the area (Cattle Egret and Black-faced Monarch) (Appendix 5).

[5] The analysis of bat calls using the Anabat system is based on the characterization of echolocation calls, which are species specific (de Oliveira, 1998). If the call is short or if there is interference then sometimes the calls cannot be accurately assigned to species. During the characterization of calls, each call is assigned to a "definite", "probable" or "possible" category. In the case of the Large-footed Myotis call in the current study, the call was short and it was assigned to a probable category.

4.2.3 Significant Species of Animal

A total of 64 threatened or Migratory animal species or their habitat have been previously recorded within 10 km of the study area (DECC Atlas of NSW Wildlife and DEWHA EPBC Online Database). Of the total, 47 have actual or potential habitat within the study area (Appendix 6). Of these 47 species, 40 are listed as threatened under the TSC Act, 11 are listed as threatened under the EPBC Act and 13 are listed as Migratory under the EPBC Act (Appendix 6).

4.2.4 Endangered Animal Populations

The Emu, *Dromaius novaehollandiae*, is listed as an endangered population in the NSW North Coast Bioregion. The population within the bioregion is isolated from other populations in the Sydney Basin and New England Tableland Bioregions (NSW Scientific Committee 2002a). The majority of records are concentrated between Coffs Harbour and Ballina. There are no previous records of this species within 10 km of the study area, and although they can occasionally occur in littoral rainforest, potential habitat within the study area is very limited.

4.3 Koala Habitat (SEPP44)

Although SEPP 44 does not apply to the proposed upgrade (Section 3.4), it has been considered in this assessment so as to identify potential issues associated with Koalas.

Tallowwood *Eucalyptus microcorys*, considered a Koala feed tree (as listed on SEPP 44), was recorded within the southern section of the study area. However, under SEPP 44 potential koala habitat is defined as “areas of native vegetation where the trees of the types listed in Schedule 1 (Koala feed trees) constitute at least 15% of the total number of trees in the upper or lower strata of the tree component”. The number of Tallowwoods within this area do not constitute 15%, hence the study area cannot be considered potential Koala habitat and as such any modification of this vegetation is unlikely to impact this species. It should be noted that all koala feed trees within the study area have been planted, and do not occur naturally.

The closest known record of Koala occurs within a Eucalypt plantation approximately 200 m to the east of the study area in the Ewingsdale/Bangalow Section (Figure 2).

4.4 Wildlife Corridors and Connectivity

Wildlife corridors can be best defined as “retained and/or restored systems of

(linear) habitat which, at a minimum enhance connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation" (Wilson and Lindenmayer 1995). Alternatively they can be defined as "linear habitats that differ from a more extensive surrounding matrix. Frequently, they link one or more patches of habitat in the landscape, but they may also occur as isolated lines of habitat" (Bennett 1990).

4.4.1 Corridors and Connectivity in and Around the study area

Throughout the study area there are a number of areas of significant vegetation in both the east and west, which either the current highway or the proposed upgrade would be likely to pass between (Figure 6). It should be noted that due to the large amount of clearing that has taken place in this landscape, even small patches of vegetation can be considered to be of high conservation value.

A number of regional, sub-regional and local corridors have been identified within the locality. Figure 6 shows key habitat and corridors as identified by DECC (Scotts et al. 2000) and Byron Shire Council. Byron Shire Council mapping of wildlife corridors closely follows those of DECC, although they include additional areas to the DECC corridors (see Byron Biodiversity Conservation Strategy). These mapped outputs provide an indicative representation and consolidation of areas of potential high conservation value for priority forest fauna and habitat corridors that link these across the landscape. These maps are based on a regional scale representation of potential habitat and linking habitat for species and species assemblages (Scotts 2001) and form part of a large network of vegetation patches. Connectivity among them should be maintained wherever possible. At the regional scale, three major corridor linkages cross the study area and one runs down the eastern boundary of the study area. The proposed upgrade is likely to cross a portion of one sub-regional corridor linkage.

The wildlife corridors in the locality are described below and shown in Figure 5.

Ewingsdale to Bangalow

Crossing the northern section of the study area, lying along the St Helena Road ridgeline and then down to the coastal floodplains, is a string of Lowland Rainforest and Camphor Laurel patches which lie within two east-west DECC sub-regional wildlife corridors (Figure 5). The northern corridor links Goonengerry National Park to the northwest with Tyagarah Nature Reserve to the northeast, while the southern corridor links Skinners Shoot with St Helena and the Goonengerry-Tyagarah corridor. Cleared areas, patches of Camphor Laurel and the existing Pacific Highway already fragment these corridors.

Bangalow to Newrybar

To the southeast of Bangalow a u-shaped sub-regional corridor links Newrybar Swamp with Piccadilly Hill. Although this corridor contains a number of patches of high quality Lowland Rainforest, cleared areas and Broken Head Road already heavily fragment these patches. This corridor is highly fragmented and probably not functional for most animal species.

Newrybar to Tintenbar

South of Tintenbar an east-west DECC regional corridor crosses immediately south of the study area from Ballina Nature Reserve in the east to Emigrant Creek near Tintenbar in the west and south to Uralba Nature Reserve. Potential route options may cross this corridor, although it is already highly fragmented by cleared areas and the existing Pacific Highway.

Ballina Council are finalising a Biodiversity Conservation Strategy, which will identify wildlife corridors and patches of vegetation of high conservation value. Discussions with Ian Gaskell of Ballina Council identified that a wildlife corridor is likely to cross the study area from Ballina Nature Reserve in the east along Sandy Flat Road to Emigrant Creek near Tintenbar in the west and then north along Emigrant Creek to Killen Falls and Emigrant Creek Dam. The exact location of this corridor has not been finalised, but is likely to be similar to the DEC corridor for the Lower Section (Figure 5). Until the location of the corridors and vegetation of high conservation value are published, close consultation with Ballina Council will be maintained during the construction phase of the proposed upgrade

Ewingsdale to Ballina Nature Reserve

To the east of the study area, along the coast, is a system of linked north-south regional corridors identified by Byron Shire Council and DECC. From north to south they link Tyagarah Nature Reserve, Cumbebin Swamp Nature Reserve, Arakwal National Park, Seven Mile Beach and Ballina Nature Reserve. All the east-west corridors discussed above link these north-south corridors with vegetation patches to the west of the study area. Although these north-south corridors are better vegetated than those discussed above, they are still fragmented by numerous roads, two railway lines, cleared areas and the townships of Ewingsdale, Bryon Bay, Suffolk Park and Lennox Head.

Riparian vegetation

Riparian vegetation is important for a range of species, providing a movement corridor along creek lines and rivers, as well as providing a filtration buffer for runoff into the creeks and rivers. For this reason riparian vegetation should be avoided where possible and, for any riparian vegetation impacted, the implementation of fauna mitigation measures such as underpasses will need to be considered. Riparian vegetation has been given a higher constraint level than

similar non-riparian vegetation in recognition of its importance as habitat and a wildlife corridor and the role it plays in the protection of aquatic ecosystems.

Platypuses have been previously recorded by local residents at numerous locations within the study area. Although the Platypus is not listed as a threatened species on either the TSC or EPBC Acts, major impacts to sites containing Platypus should be avoided. It is unlikely that the Platypus or its habitat would be significantly impacted by the proposed highway upgrade as waterways that may be crossed are small and could be done so with single span bridges, thus causing minimal disturbance to waterways and riparian zones.

Fauna movement

A range of different animal species will exist on both sides of the proposed upgrade, utilising the existing corridor network. How species use the corridor network will depend largely on the home and activity ranges of the species, their habitat requirements and the ecological characteristics of the corridor. For example, some large or mobile species may make direct movements through the corridor network, moving from one patch of habitat to another. These direct movements may be on the scale of a foraging expedition or a migration (Bennett 1990). Other species may have movements by single individuals punctuated by pauses in the corridor, which can last anything from a small foraging or resting bout to weeks and even months. If the corridor contains sufficient resources to maintain a population, then continuity through the corridor may be via gene flow though the resident population (Bennett 1990, Wilson and Lindenmayer 1995).

Roads can generally cause a significant barrier to the movement of animals within a wildlife corridor network (Andrews 1990, Bennett 1991, Cuperus *et al.* 1999). Although not necessarily totally stopping all movements of animals, a road without mitigation measures may reduce the number of successful movements through a corridor by acting as a deterrent (Barnett *et al.* 1978, Bennett 1991) or by increasing mortality as they move through the corridor (Van der Zande *et al.* 1980, Andrews 1990, Forman *et al.* 2003). Given that a large proportion of the study area has been heavily disturbed due to agricultural and urban development and the surrounding matrix consists primarily of cleared lands for agriculture, fauna movement barriers are to some extent already in place. However, the proposed upgrade may increase the effectiveness of the barrier in hindering fauna movements and the design phase may be seen as an opportunity to increase or maintain connectivity through mitigation measures such as fauna underpasses.

The subregional corridor within the study area largely consists of isolated patches of vegetation providing ‘stepping stones’ for fauna movement in the region. In this section of the proposed upgrade the road mostly tunnels underground, and hence, reduces the impacts on native vegetation, habitats and

the wildlife corridor. Although expected to be minor, it is likely that there would be some increase in barrier effects to fauna movement from the proposed upgrade and hence fauna mitigation measures, such as underpasses, as a means of maintaining connectivity could be implemented (these are discussed in Section 5.2).

5.0 IMPACTS AND MITIGATION

This section details the types of impacts that may be experienced as a result of the construction and operation of a road, with specific reference to the Pacific Highway between Tintenbar and Ewingsdasle. However, many of these impacts can be mitigated, greatly reducing or eliminating the impacts.

5.1 Potential Impacts

Potential impacts resulting from roads on terresrtical ecological values include the following:

- Vegetation clearance and habitat loss
- Increased fragmentation
- Edge effects
- Increased mortality
- Weed invasion

Each of these potential impacts are discussed below.

5.1.1 Vegetation Clearance/Habitat Loss

Impacts of vegetation clearing can result in the loss of plant species and fauna habitat features that occur in the area. In the study area this would include nesting habitat and roosting hollows (although the potential for tree hollows in the study area is limited), as well as feeding and shelter resources.

Vegetation clearing itself would be minimal and largely involves removal of vegetation that is already disturbed. While these areas do provide a range of food and shelter for vertebrate and invertebrate fauna, as well as habitat connectivity, the small areas to be cleared will not significantly impact fauna habitats in the study area.

Table 6 shows the area of each plant community recorded in the study area that would be impacted by the proposed upgrade. The indirect impacts are calculated based on the 50 m average extent of edge effects, calculated by buffering the road footprint (plus a 4 m buffer) by 50 m, as described by Biosis Research (2000) and Bali (2005) (see Section 5.1.3). Overall, only small fragmented patches of native vegetation would be impacted by the proposed upgrade, with only the edges of these patches being directly impacted. No new edges would be created by the proposed upgrade. The impacts of this vegetation clearing on

threatened species habitat are discussed in Section 6.0.

Table 6: Area of each plant community impacted by the proposed upgrade

Plant Community	Impacted Area (ha)	
	Direct	Indirect (Edge Effects)
Lowland Rainforest	2.0	3.6
Camphor Laurel	5.7	9.5
Plantation	2.7	0.5
Total	10.4	13.6

5.1.2 Fragmentation

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with a new habitat type occurring in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the fauna species remaining within the fragments (Bennett 1990, 1993, MacNally 1999) and can provide suitable conditions for weed species to establish, which may outcompete native plant species. Although the newly created habitat will be used by some species, they are usually generalist species and are often considered aggressive (e.g. Noisy Miners (Loyn *et al.* 1983)), further decreasing population levels of the species remaining in the fragments. In addition to the loss of total habitat area, the process of fragmentation can impact on the species within the newly created fragments in a number of ways (e.g. barrier effects, genetic isolation and edge effects). The degree to which these potential impacts affect the flora and fauna within the newly created fragments depends on a number of variables including distance between fragments, local environmental conditions, the species present and mitigation measures (see Section 5.2). Some of the potential impacts are summarised below:

Barrier Effects. Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of fragmented habitat. This could result in either a complete halt to movement or a reduced level of movement between fragments. Roads through areas of native vegetation can act as barriers, with barrier effects greater for some species than others (Goosem 2002). Species most vulnerable to barrier effects include rare species (even a small reduction in movements can reduce genetic continuity within the population hence reducing the effective population size), smaller ground-dwelling species and species with low mobility. Species least vulnerable to barrier effects tend to be those that are highly mobile (e.g. birds), although even these species can vary in their response to barriers

Genetic Isolation. Genetic isolation occurs where individuals from a population within one fragment are unable to interbreed with individuals from populations in adjoining fragments. Genetic isolation can lead to inbreeding and genetic drift problems for populations isolated within a fragment.

Edge Effects. A zone of changed environmental conditions (i.e. altered light levels, wind speed, temperature) occurs along the edges of habitat fragments (see Section 5.1.3).

The study area has been highly disturbed and contains a number of isolated patches of remnant vegetation. The proposed upgrade generally follows the path of the existing Pacific Highway, thereby minimising further fragmentation of habitats and barrier effects. The proposed upgrade is unlikely to increase the impact of fragmentation on threatened species and endangered ecological communities in the local area given the high degree of fragmentation in the existing landscape.

Wildlife Corridors

The proposed upgrade crosses a sub-regional wildlife corridor in the northern section of the study area (Figure 5). However, the proposal is not likely to impact on this wildlife corridor given that the corridor is not currently functional due to the existing fragmentation. Further, the road will be tunneled through St Helena ridge, thereby minimising fragmentation within the identified corridor and not hindering future efforts to improve the functionality of the corridor.

5.1.3 Edge Effects

Edge effects are zones of changed environmental conditions (i.e. altered light levels, wind speed, temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators (Berry 2002). This new zone of habitat inside the edge of a fragment can also exacerbate barrier effects.

Biosis Research (2000) noted that there are limitations to edge effect studies, with a study by Murcia (1995) noting that it is unrealistic to expect all variables to vary equally with distance from the edge. As edge effects varied between community types and abiotic effects were the most consistent indicator of edge effects (measuring less than or equal to 50 m in most studies), Biosis Research (2000) concluded that average edge effects generally occur up to 50 m away from the road edge. Similarly, the maximum extent of edge effects for a reliable biological indicator species, the epiphytic lichen, is up to 50 m from the forest

edge (Esseen and Rehnhorn 1998).

Specifically, edge effects associated with roads can include the degradation of adjacent habitat through:

- Changes in microclimate (e.g. temperature, wind, light humidity);
- Changes in hydrology (i.e. surface and sub-surface water flows);
- Changes in floristics (i.e. species composition and abundance);
- Alteration to the pattern and frequency of fire;
- Invasion by exotic plant and animal species;
- Increase in sedimentation;
- Increase in tree death (e.g. dieback, impact on root zone);
- Increase in rubbish and water pollution; and
- Improved access for predators (Bali 2000).

Edge effects may not affect both sides of the road equally and may be greater if they are downslope, downwind or surrounded by more suitable habitat (Forman and Alexander 1998, Biosis Research 2000).

Using the estimate of edge effects of 50 m proposed by Biosis Research (2000), the road footprint (plus a 4 m buffer) was buffered by 50 m to calculate new edge effects from the proposed upgrade. It was calculated that the proposed upgrade would impact 3.6 ha of native vegetation through new edge effects (see Table 6). An additional 9.8 ha of non-native vegetation will also be impacted by new edge effects. However, the proposed upgrade would not create any new edges in plant communities and habitats in the study area, as the impacted patches are small and isolated, and already heavily impacted by edge effects due to their small size and edge to area ratio. No DECC estates, crown land or State forests would be impacted by edge effects from the proposed upgrade.

5.1.4 Mortality

Fauna injury or death can occur as a result of highway construction and operation in two ways:

- *During the break-out phase of construction (when all vegetation is removed to expose a natural earth substrate).* Habitat clearance may result in the injury or death of resident or visiting fauna. Some species can more readily evade injury by flying (birds) or ‘running’ away (e.g. the larger mammals).

Many species, however, are unlikely to move quickly enough to avoid being caught. For example, many nocturnal species (possums, gliders, bats) shelter during the day and smaller ground-dwelling species, such as lizards and snakes, are unable to move rapidly and over large distances.

- *Road kills.* Mortality due to road kill during operation has the potential to affect local fauna species at the sub-population level. In general, rates of road kill mortality are likely to be directly proportional to the distance of native vegetation/fauna habitat crossed by the Highway (Forman *et al.* 2003). However, other factors such as the design of the road (e.g. raised or not, presence of walls and fences, fauna underpasses) also influence road kill mortality. Generally, the effects of road kill mortality on sub-populations cannot be accurately predicted without more detailed demographic data than is available for species in the local area.

The RTA has policies and guidelines in place to manage the risk of fauna mortality during construction (see Section 5.2.4).

5.1.5 Weeds

Weed invasion can be a significant problem along the edges of habitat fragments. Along these boundaries there are changes in the environment (edge effects) including, altered light levels, wind speed, temperature, humidity and runoff. These altered conditions allow the colonisation and growth of weeds which would themselves result in further environmental changes that promote the colonisation and growth of weed species within the area. Due to these environmental changes, weeds may be able to outcompete native plant species and (at worst) could result in the loss of the native plant community in that area. Given the small size, isolation and poor condition of the majority of patches of vegetation that would be impacted, the proposed upgrade is not likely to increase the impact of weed invasion in the study area. However, mitigation measures are recommended to reduce the likelihood of increased weed invasion in the impacted patches (see Section 5.2 below).

5.2 Mitigation Measures

The key policy principle of the RTA's Road Development and Impact on Habitat Amelioration Measures is that "in principle, the planning and construction of roads should, in order of consideration endeavour to:

1. Avoid impacts on habitat though the planning process.

2. Minimise impacts on habitat through the planning process.

3. Mitigate impacts on habitat, through the use of a range of amelioration

measures" (RTA 2001).

Where possible important ecological features in the local area have been avoided during the initial route selection stage, such as patches of Lowland Rainforest and the threatened plant species *Diploglottis camfieldii* and *Syzygium moorei*. The proposed upgrade has been designed, where possible, to minimise impacts on habitat. Mitigation measures are discussed below.

5.2.1 Vegetation Clearing/Habitat Loss

In order to mitigate some of the impacts of vegetation clearing and habitat loss it is recommended that:

- Vegetation clearing is restricted to those areas where it is necessary;
- Where clearing does occur, the area should be fenced with highly visible temporary fencing or flagging tape to ensure that clearing does not extend beyond the area necessary;
- Known locations of threatened plants should be avoided where possible and fenced to protect them from direct and indirect impacts, particularly those species that occur on the edge of the Subject Site (*Macadamia tetraphylla, Tinospora tinosporoides, Diploglottis camfieldii* and *Syzygium moorei*). This may involve fencing to keep out construction vehicles and prevent stockpiling. Contracters should be advised of the presence of the threatened plant species and measures required to protect them. Where threatened plants cannot be protected in-situ, translocation of the plants and collection of propagation material should be considered. A translocation plan should be prepared in consultation with DECC, additional information on translocation is alo available at Ballina Council and/or the local Botanic Gardens.
- Clearing of vegetation should comply with the RTA Pacific Highway Office guidelines for fauna rescue associated with roadworks. These guidelines have been developed in consultation with DECC and cover the felling of both non-habitat and habitat trees and the rescue and relocation of fauna;
- Where suitable, nest boxes should be used to replace any removed tree hollows. Such a program should be developed in consultation with DECC;
- Vegetation within the road reserve and adjacent to areas of vegetation clearing should be managed to reduce invasion of noxious weed species, this may include controlling weeds at their point of source (i.e. the area of clearing); and,
- A Vegetation Management Plan (VMP) should be prepared prior to construction, detailing restoration, regeneration and rehabilitation of areas of

native vegetation in the vicinity of the proposed upgrade. The VMP should also detail appropriate management for threatened species that are known to occur in the close vicinity of the proposed upgrade, including monitoring during and after construction works to ensure impacts are minimised. Appropriate management may include fencing the habitat supporting the threatened species from the area of direct impacts, signage and educating contractors of the presence of the species, its significance and no-go zones to protect the species. The VMP should be integrated with the landscape plan for the project.

5.2.2 Edge Effects

Mitigation measures related to edge effects relate generally to reducing impacts outside of the direct development zone, controlling possible impacts at their source within the road reserve and reducing the hardness of the edge between the extent of earthworks and native vegetation. Measures that are relevant to the current upgrade of the Pacific Highway include:

- Minimising disturbance to habitat adjacent to construction (e.g. the use of visible temporary fencing).
- Minimising disturbance wherever possible to stream banks and streambeds. This may be more easily achieved with some bridges, but will be impossible in the case of culverts.
- Siting all ancillary building and works in cleared or otherwise disturbed areas away from waterways and other sensitive areas.
- Avoiding stockpiling materials on adjacent vegetation.
- Managing general construction activities to appropriately store waste material and/or contaminants away from adjacent habitats.
- Implementing soil erosion and sedimentation control measures.
- Implementing a weed management strategy within the road reserve, to be incorporated into the VMP.
- Using locally indigenous (local provenance) species for landscape plantings and revegetation.

Compensatory Habitat

Biosis Research (2000) determined that a 1:1 ratio to compensate for edge effects was not appropriate as edge-effected habitat can still be utilised by flora and fauna species, including threatened species. In a review of Australian studies,

Biosis Research (2000) determined that the edge zone was 60% less suitable, or provided 60% less habitat for these species. It was therefore suggested that a 0.6:1 ratio could be used, which in practical terms equates to a 30 m strip of habitat (0.6 m x 50 m) that should compensate for edge effects along habitat removed for new road corridors. Biosis Research (2000) defined a new road corridor as one that is greater than 100 m from an existing road as a new 50 m edge effect would not occur until the new road was 100 m from an existing edge (50 m existing edge + 50 m new edge = 100 m).

Biosis Research (2000) also recommended that for upgrades, compensatory habitat should only apply to key habitat removed and not to edge effects as edge effects are already existing. Biosis Research (2000) defines key habitat as areas that support flora and fauna species, populations or ecological communities considered to be of significance because they are listed in relevant legislation. In consultation with DECC it was determined that all native vegetation within the study area should be considered as key habitat. This is due to the extensive distribution of regional key habitat and corridors identified by DECC (Scotts *et al.* 2000) and the large number of EECs, threatened flora (Figure 4) and fauna (Figure 4) species within the Subject Site.

The proposed upgrade does not result in any new edge effects, and therefore, compensatory habitat for edge effects is not required. Further existing edge effects have been removed from compensatory habitat calculations. The proposed upgrade removes 2.0 ha of native vegetation that needs to be compensated for in consultation with DECC.

5.2.3 Fragmentation

During the design and selection of the preferred route a number of features were included to reduce the effects of habitat fragmentation. For example, where possible disturbances were kept to one side of an area of vegetation rather than be put through the middle.

In order to further mitigate the impacts of fragmentation it is recommended that:

- Only native and locally indigenous plants should be used in the landscaping to reduce weed invasion into the surrounding vegetation; and,

- Fauna crossing structures must be included in the design in order to maintain connectivity between habitats on both sides of the road (see Section 0). Given that connecting habitat on either side of the proposed upgrade only occurs within riparian corridors, detailed bridge design and associated landscape treatment should take into account terrestrial fauna movement that is likely to occur along riparian corridors. This should include the use of fauna fencing

where appropriate, to guide fauna to the riparian corridor.

Fauna crossings

In order to reduce impacts of habitat fragmentation, fauna crossing structures should be included in the design. Underpasses can be either constructed solely for the purpose of fauna movements or can be modified from existing structures such a box culverts (AMBS 2002), or in this instance, bridges. Suitability of the structures as fauna underpasses would depend on a number of factors including:

- The regional continuity of habitat in the area.
- Habitat directly on either side of the structure.
- The dimensions of the structure (width, height and length).
- The species in the local area.

Structures such as exclusion fences and refuge poles can also increase the effectiveness of underpasses.

Within the proposed upgrade the following points were considered when deciding on the need and suitability of fauna crossing structures:

- The regional connectivity within the local area. This is based on key habitat and corridor mapping produced by DEC (Figure 6). This mapping looks at the broad-scale connectivity within the whole region and assigns priority fauna species to different linkages.
- The size and location of vegetation patches on both sides of the proposed highway and their suitability as fauna habitat. Within the broad-scale corridors, relatively continuous habitat is one factor that contributes to the overall structural connectivity. Outside of the wider corridors, local connectivity between small patches of vegetation can also be important in maintaining local populations.
- Species that are likely to need or use fauna crossing structures at that point.
- Current and, where possible, future land use on either side of the proposed highway and other potential barriers.
- The feasibility of constructing a fauna crossing structure at that point due to engineering constraints.

A number of drainage structures and bridges would be included in the upgraded highway section and some of these may serve as fauna underpasses. Based on the above features and following discussions with RTA and Arup engineers, a

number of drainage and associated structures have been identified as suitable for use as fauna crossing points. These structures are detailed below.

Given the highly fragmented state of the vegetation patches surrounding the study area, including within the recognised DECC and Byron Bay Council wildlife corridors, and the fact that the proposed upgrade does not increase fragmentation significantly, there is little opportunity to improve connectivity in the local area through the use of fauna underpasses. The wildlife corridor lying across St Helena ridgeline is not significantly impacted by the proposed upgrade as it passes under this corridor in a tunnel. A small amount of vegetation within this corridor would be directly impacted by the proposed upgrade, but its functionality as a wildlife corridor will not be diminished. There is also opportunity to maintain connectivity between patches of vegetation immediately south of St Helena ridgeline, and culverts used to cross the upper reaches of Tinderbox Creek should be modified to facilitate fauna movements.

The most functional corridors in the surrounding area are riparian vegetation, which generally provide a continuous strip of vegetation through an otherwise cleared landscape. Therefore, the greatest opportunity for maintaining connectivity across the proposed upgrade is through the design of bridges over creeks and rivers, so that they provide sufficient clearance (both height and the space between the embankments and the watercourse) for fauna to move under them. Watercourse crossing where bridges will enable unrestricted movement of fauna include at Emigrant, Skinners and Byron Creeks. Other drainage structures along the proposed upgrade would also be suitable as fauna underpasses, but these have no connecting vegetation, and therefore, no fauna are likely to be present within their vicinity or have a need to utilise such a structure.

It is recommended that fauna fencing is used on all structures identified as fauna underpasses. While there is mixed evidence that fauna exclusion fencing guides fauna into structures, it does appear to reduce road kills where it is installed (AMBS 1997, 2002).

5.2.4 Mortality

A number of recommendations should be implemented to reduce the risk of mortality.

Prior to and during construction:

- Minimise clearance and disturbance of fauna habitat, particularly hollow-bearing trees and other habitat features where fauna may be sheltering. Although this may be difficult to achieve in areas where earthworks are to proceed, it should be particularly noted within the road reserve where

temporary sites such as stockpiles may be placed.

- Clearing of vegetation should follow the RTA (Pacific Highway Office) requirements for fauna rescue on Pacific Highway projects as updated from time to time. These guidelines are a dynamic document produced in consultation with DECC. They include procedures for clearing of non-habitat and habitat trees, the relocation of rescued fauna and the inclusion of wildlife specialists in the process.

To reduce the risk of roadkill once the highway is operational:

- Design barriers to prevent access to the highway by animals e.g. possums, wallabies. This should however not reduce connectivity in the area and should be related to fauna crossings structures.

- Avoid vegetation overhanging barriers that may encourage fauna crossing into the road reserve.

- Carefully consider location and type of plant species for the verges and median strip so that they do not attract fauna species. For example, *Allocasuarina* spp. should not be planted in the median strip since they might attract Glossy Black-cockatoos. Similarly, Koala feed trees should not be used for plantings in the road reserve generally.

5.2.5 Weeds

A number of recommendations should be implemented to reduce the impact of weed invasion on native plant communities:

- Restrict the area of native vegetation disturbed during construction works.

- Restrict stockpiling to areas already cleared of vegetation.

- Control drainage that may contain weed seeds or high levels of nutrients.

- Use weed-free topsoil in landscaping and revegetate disturbed sites with locally indigenous species (local provenance). In areas where vegetation to be cleared is in good condition, topsoil may be stockpiled and used for revegetation following the completion of construction works. Generally, native vegetation remnants within the study area are in good-moderate condition however, soil (seedbank) stockpiling should be restricted to areas in good-moderate condition, avoiding disturbed areas such as road margins. Revegetation using stockpiled soil should also include planting local native species to stabilise the soil as well as ongoing weed control.

- Monitor and control weed populations that establish on disturbed areas, with

particular attention to eradication of noxious weeds. Weed invasions should be monitored and controlled by person experienced in weed management.

- A Weed Management Plan should be incorporated into the VMP, detailing necessary weed control works, particularly in areas where the weeds may impact on threatened species and/or their habitats.

5.3 Regional Scale Cumulative Impacts

The proposed upgrade occurs in a highly development landscape, dominated by rural development. Consequently, much of the native vegetation of the local area has been cleared and the remaining remnants are small, isolated and fragmented. Due to its location within a highly developed landscape, the proposed upgrade is one of many developments impacting biodiversity in the local area.

The biodiversity impacts of the entire Pacific Highway Upgrade Program are greater than those assessed in association with the Tintenbar to Ewingsdale upgrade. Sections of the highway are at different stages of planning and development, with some sections already upgraded and others proposed for upgrade. The cumulative impacts of the entire Pacific Highway Upgrade Program would include a greater extent of clearing of native vegetation and habitats, including endangered ecological communities and threatened species habitat, as well as further fragmentation of habitat.

Table 7 details the 13 Pacific Highway Upgrade Program projects that have been declared critical infrastructure by the Minister for Planning under Section 75B(1) of the *Environmental Planning and Assessment Act 1979.* Twelve of the 13 projects (exception F3 to Raymond Terrace) are located within the North Coast bioregion (IBRA 5-1, Thackway & Cresswell 1995). In relation to the Pacific Highway Upgrade Program, the proposed upgrade represents 3.8% of the total length of the Pacific Highway to be upgraded, 0.7% of the total vegetation to be removed (note: for the proposed upgrade, this includes non-native treed vegetation) and approximately 0.4% of the likely extent of endangered ecological communities to be removed (see

Table 7). However, it should be noted that the final route of some of these projects have not yet been finalised and the total extent of vegetation clearing may change as the projects develop.

Table 7: Critical infrastructure project details

Project name	Project status	Project length (km)	Likely vegetation disturbance (ha)	Likely endangered ecological community disturbance (ha)
Banora Point	Environmental assessment submitted for approval	2.5	8	4
Tintenbar to Ewingsdale	Environmental assessment commenced	17	10	2
Woodburn to Ballina	Preferred route selected	36	66	52
Iluka Road to Woodburn	Concept design selected	35	117	31
Wells Crossing to Iluka Road	Preferred route selected	71	410	88
Woolgoolga to Wells Crossing	Preferred route selected	27	207	33
Sapphire to Woolgoolga upgrade	Environmental assessment submitted for approval	25	83	18
Coffs Harbour Bypass	Concept design included in LEP	55	Not yet available	Not yet available
Macksville to Urunga	Environmental assessment commenced	3	Not stated	Not stated
Warrell Creek to Urunga	Environmental assessment commenced	45	236	82
Kempsey to Eungai	Environmental assessment submitted for approval	40	258	65
Oxley Highway to Kempsey	Environmental assessment commenced	37	229	66
F3 to Raymond Terrace	Preferred route selected	14	Not yet available	Not yet available

Note: these figures are based on publically available documents relating to each project and the values may change as the environmental assessment, concept design and detailed design progresses.

In terms of endangered ecological communities being impacted, the proposed upgrade represents 21% of the clearing of lowland rainforest in relation to the 13 projects as a whole (Table 8). It should be noted however, that this percentage represents a relatively small area of clearing (2 ha) and that only nine of the 13 projects are at an assessment stage in which details of the extent of clearing has been determined. The proposed upgrade has a large proportional impact in relation to the overall known impacts of the larger Pacific Highway Upgrade Program, however, the areas involved are relatively small and are considered to represent a relatively minor regional scale cumulative impact.

Table 8: Endangered ecological communities affected by the proposed u[pgrade and their extent of clearing in other critical infrastructure projects (Pacific Highway Upgrade Program projects only)

Project	Lowland Rainforest (ha)
Tintenbar to Ewingsdale	2
Banora Point Upgrade	2.5
Warrell Creek to Urunga upgrade	4.7
Total	9.2

Note: Only nine of the 13 projects have as yet determined the extent of vegetation clearing by community.

6.0 ASSESSMENT OF IMPACT ON THREATENED BIOTA

This report has been prepared to meet the requirements of Part 3A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act). Threatened biota listed under the TSC and EPBC Acts are considered.

Potential habitat for threatened plant and animal species would be impacted by the proposed upgrade. As discussed in Section 5, impacts of the proposed upgrade on threatened flora and fauna include loss of habitat, modification of habitat (weed invasion, edge effects), fragmentation and mortality. The direct and indirect impacts associated with the modification and/or removal of habitat may impact threatened species by causing any of the following situations to arise:

- Death or injury of individuals.
- Loss or disturbance of limiting foraging resources.
- Loss or disturbance of limiting breeding resources.

Limiting resources are habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roosts) that occur at low densities, with high levels of competition from a range of species. However, for some species or broad scale impacts, limiting resources include specialised foraging habitats/resources that have a restricted distribution (e.g. Allocasuarina for Glossy Black-cockatoos).

The study area contains potential habitat for 82 threatened plants and animals likely to be impacted by the proposed upgrade (Tables 9 and 10 below). The impact of the proposed upgrade on these threatened species and their habitats is discussed below. Refer to appendices 4 and 6 for detailed habitat requirements for each of the threatened species listed in Tables 9 and 10.

It should be noted that there are a number of threatened animal species that have potential habitat within the study area but are unlikely to be impacted by the proposed upgrade. These animal species generally forage over a wide area; are highly mobile and their specific breeding or roosting resource will not be impacted by the proposed upgrade (e.g. cave dependant bats and migratory birds).

Table 9: Threatened plants species with known/potential habitat likely to be impacted by the proposed upgrade

Scientific Name	TSC Act	EPBC Act	ROTAP	Potential habitat in study area?
Acacia bakeri	V	-	-	Yes – Lowland Rainforest.
Acalypha eremorum	E1	-	-	Yes. Lowland Rainforest.
Amorphospermum whitei	V	-	3Ra	Yes. Lowland Rainforest.
Archidendron hendersonii	V	-	-	Yes. Lowland Rainforest.
Arthraxon hispidus	V	V	3V	Yes. Lowland Rainforest.
Corokia whiteana	V	V	2Vi	Yes. Lowland Rainforest.
Davidsonia jerseyana (syn. *Davidsonia pruriens var. jerseyana*)	E1	E	2Ei	Yes. Lowland Rainforest and Camphor Laurel.
Davidsonia johnsonii	E1	E	2Ei	Yes. Lowland Rainforest.
Desmodium acanthocladum	V	V	2V	Yes. Lowland Rainforest.
Diploglottis campbellii	E1	E	2E	Yes. Lowland Rainforest and Camphor Laurel.
Drynaria rigidula	E1	-	-	Yes. Lowland Rainforest.
Elaeocarpus williamsianus	E1	E	2Ei	Yes. Lowland Rainforest and Camphor Laurel.
Endiandra floydii	E1	E	2V	Yes. Lowland Rainforest.
Endiandra hayesii	V	V	3V	Yes. Lowland Rainforest.
Endiandra muelleri ssp. *bracteata*	E1	-	-	Yes. Lowland Rainforest.
Floydia praealta	V	V	3V	Yes. Lowland Rainforest.
Gossia fragrantissima	E1	E	3E	Yes. Lowland Rainforest.
Grevillea hilliana	E1	-	-	Yes. Lowland Rainforest.
Hibbertia hexandra	E1	-	3R	Yes. Lowland Rainforest.
Hicksbeachia pinnatifolia	V	V	3R	Yes. Lowland Rainforest.
Isoglossa eranthemoides	E1	E	2E	Yes. Lowland Rainforest.
Macadamia tetraphylla	V	V	2V	Yes. Lowland Rainforest.
Marsdenia longiloba	E1	V	3RC	Yes. Lowland Rainforest.
Melicope vitiflora	E1	-	-	Yes. Lowland Rainforest.
Ochrosia moorei	E1	E	2Ei	Yes. Lowland Rainforest.
Owenia cepiodora	V	V	2Vi	Yes. Lowland Rainforest.
Phaius australis	E1	E	3Va	Yes. Lowland Rainforest.
Phyllanthus microcladus	E1	-	-	Yes. Lowland Rainforest.
Randia moorei	E1	E	3E	Yes. Lowland Rainforest.
Senna acclinis	E1	-	3R	Yes. Lowland Rainforest.
Sophora fraseri	V	V	3V	Yes. Lowland Rainforest.
Syzygium hodgkinsoniae	V	V	3V	Yes. Lowland Rainforest.
Syzygium moorei	V	V	2Vi	Yes. Lowland Rainforest.
Syzygium paniculatum	V	V		Yes. Lowland Rainforest.
Tinospora tinosporoides	V	V	3R	Yes. Lowland Rainforest.
Xylosma terrae-reginae	E1	-	-	Yes. Lowland Rainforest.

Table 10: Threatened animal species with known/potential habitat likely to be impacted by the proposed upgrade

Scientific Name	Common Name	TSC Act	EPBC Act	Potential habitat in study area?
Amphibians				
Assa darlingtoni	Pouched Frog	V	-	Yes
Litoria aurea	Green and Golden Bell Frog	E1	V	Yes
Birds				
Amaurornis olivaceus	Bush-hen	V	-	Yes
Anseranas semipalmata	Magpie Goose	V	-	Yes
Ardea ibis	Cattle Egret		M	Yes
Coracina lineata	Barred Cuckoo-shrike	V	-	Yes
Cyclopsitta diophthalma	Coxen's (Double-eyed) Fig-Parrot	E1	E	Yes
Ephippiorhynchus asiaticus	Black-necked Stork	E1	-	Yes
Erythrotriorchis radiatus	Red Goshawk	E1	VM	Yes
Gallinago hardwickii	Latham's Snipe	-	M	Yes
Grus rubicunda	Brolga	V	M	Yes
Haliaeetus leucogaster	White-bellied Sea-eagle		M	Yes
Hirundapus caudacutus	White-throated Needletail		M	Yes
Irediparra gallinacean	Comb-crested Jacana	V	-	Yes
Ixobrychus flavicollis	Black Bittern	V	-	Yes
Lophoictinia isura	Square-tailed Kite	V	M	Yes
Monarcha leucotis	White-eared Monarch	V	-	Yes
Monarcha melanopsis	Black-faced Monarch	-	M	Yes
Monarcha trivirgatus	Spectacled Monarch	-	M	Yes
Myiagra cyanoleuca	Satin Flycatcher	-	M	Yes
Podargus ocellatus	Marbled Frogmouth	V	-	Yes
Ptilinopus magnificus	Wompoo Fruit-dove	V	-	Yes
Ptilinopus regina	Rose-crowned Fruit-dove	V	-	Yes
Ptilinopus superbus	Superb Fruit-dove	V	-	Yes
Rhipidura rufifrons	Rufous Fantail	-	M	Yes
Rostratula benghalensis	Painted Snipe	V	VM	Yes
Stictonetta naevosa	Freckled Duck	V	M	Yes
Turnix maculosa	Red-backed Button-quail	V		Yes
Tyto capensis	Grass Owl	V	-	Yes
Tyto novaehollandiae	Masked Owl	V	V	Yes
Tyto tenebricosa	Sooty Owl	V	-	Yes
Mammals				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Yes
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Yes
Miniopterus australis	Little Bent-wing Bat	V	-	Yes
Miniopterus schreibersii	Eastern Bent-wing Bat	V	-	Yes
Myotis macropus	Large-footed Myotis	V	-	Yes
Nyctophilus bifax	Eastern Long-eared Bat	V	V	Yes
Phascolarctos cinereus	Koala	V	-	Yes
Planigale maculata	Common Planigale	V	-	Yes
Potorous tridactylus	Long-nosed Potoroo	V	V	Yes
Pteropus alecto	Black Flying-fox	V	-	Yes
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Yes
Syconycteris australis	Common Blossom-bat	V	-	Yes
Reptiles				
Coeranoscincucs reticulatus	Three-toed Snake-tooth Skink	V	V	Yes
Invertebrates				
Thersites michellae	Mitchell's Rainforest Snail	E1	Z	Yes

6.1 Impacts to threatened plant species known to occur in the study area

Table 11 shows the impact of the proposed upgrade on the four threatened species known to occur in the study area.

Table 11: Impacts to threatened plant species known to occur in the study area

Threatened Plant Species	Directly Impacted	Indirectly Impacted
Diploglottis campbellii	Two planted individuals a in a patch of replanted Lowland Rainforest (Patch 10), west of the Pacific Highway at Newrybar (Yarrenbool Place)	One individual immediately south-east of Patch 12.
Macadamia tetraphylla	-	One planted individual near Patch 12.
Syzygium moorei	One record within Patch 5, occurring in a patch of Lowland Rainforest along the existing Pacific Highway.	One record in Patch 1, supporting 15 scattered remnant mature trees.
		One specimen to the north of patch 7 on the edge of the study area.
		One record within the Patch 10, which is planted within a revegetated patch of Lowland Rainforest.
		One record to the south-west of Patch 14, occurring as a planted tree in a garden landscape.
Tinospora tinosporoides	One recording in Patch 6, in a patch of Lowland Rainforest.	One record in Patch 14, in a patch of Lowland Rainforest.

6.2 Threatened Species Conservation Act 1995

As the project is required to meet the requirements of Part 3A of the EP&A Act, Assessments of Significance are not required. The impact of the proposed upgrade on threatened species listed under the TSC Act will be assessed in species profiles for each species potentially impacted. The format of the species profiles follows the Part 3A Guidelines for Threatened Species Assessment (DEC & DPI 2005).

Impact assessments are therefore required for the 36 threatened plant species listed under the TSC Act: The potential impact of the proposed upgrade on the above listed threatened species (

Table 9) is assessed in the species profiles in Appendix 7.

Lowland Rainforest occurs within all sections of the proposed upgrade. This community is listed on the TSC Act as an EEC. The impacts of the clearing of native vegetation on this EEC are discussed in the species profiles in Appendix 7.

Impact Assessments are required for 38 threatened animal species (

Table 10) listed on the TSC Act. Potential habitat for these threatened animal species occurs within the Rainforest and/or Camphor Laurel habitats types. The proposed upgrade is likely to modify approximately 5.6 ha of Rainforest habitat and 15.2 ha of Camphor Laurel habitat. The species profiles in Appendix 7 detail the impacts of the proposed upgrade on these animal species.

The impact assessments concluded that the proposed upgrade would have a minimal impact on threatened biota in the local area. Impacts on threatened plant species recorded in the study area (*Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei, Tinospora tinosporoides*) should be avoided where possible. Mitigation measures detailed in Section 5.2 should minimise indirect impacts.

No critical habitat listed on the TSC Act will be impacted by the proposed upgrade.

6.3 Environment Protection and Biodiversity Conservation Act 1999

Thirty-three threatened plant species listed on the EPBC Act have been previously recorded within the local area or are considered to have potential habitat in the local area (DEW EPBC Online Database) (Appendix 4, Figure 3). Four of these species were recorded within the study area (Figure 2): *Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei* and *Tinospora tinosporoides.* An additional 20 threatened species (

Table 9) listed on the EPBC Act that are known or likely to occur in the local area have been previously recorded or have potential habitat in the study area (Appendix 4). These species with known or potential habitat in the study area were assessed under the Significant Impact Criteria set out in the EPBC Significant Impact Guidelines (DEH 2006b) (Appendix 8). It was determined that the proposed upgrade was unlikely to have a significant impact on any threatened plant species. Impacts on threatened plant species recorded in the study area (*Diploglottis campbellii, Macadamia tetraphylla, Syzygium moorei, Tinospora tinosporoides*) should be avoided where possible. Mitigation measures detailed in Section 5.2 should minimise indirect impacts.

It was determined that the proposed upgrade was unlikely to have a significant impact on *Macadamia tetraphylla* and as such a referral under the provisions of the EPBC Act is not recommended for this species. However, it is recommended that the individual of this species that occurs on the edge of the proposed upgrade and is within the area of indirect impact is fenced during construction activities in order to remove the possibility of any impacts to this species. Provided this individual is adequately protected, no known records of *Macadamia tetraphylla* would be directly impacted by the proposed upgrade, except where they form part of commercial plantations.

The proposed upgrade was considered unlikely to have a significant impact on *Tinospora tinosporoides,* and, as such a referral under the provisions of the EPBC Act is not recommended for this species. However, to reduce the impact of the proposed upgrade on the species, it is recommended that the individual of *Tinospora tinosporoides* that occurs on the edge of the proposed upgrade is fenced during construction activities. If this record is adequately protected, only one known individual of *Tinospora tinosporoides* will be removed by the proposed upgrade.

The proposed upgrade was considered unlikely to have a significant impact on *Diploglottis campbellii,* provided the record of the species within the indirect impact area is protected during and after construction activities. If this record is adequately protected from construction activities, only two planted individuals of the species would be directly impacted by the proposed upgrade and, as such, a Referral will not be required.

The proposed upgrade was considered unlikely to have a significant impact on *Syzygium moorei*, provided that the three individuals within the indirectly impacted area are adequately protected during and after construction activities. As such a Referral under the provisions of the EPBC Act is not recommended for this species.

Sixty-two threatened or migratory animal species or their habitats have been previously recorded within the local area (DECC Altas of NSW Wildlife, DEW

EPBC Online Database) (Figure 4, Appendix 6).

Forty-five of the above threatened or migratory species have potential habitat within the study area (

Table 10). Significant impact criteria assessments have been prepared for these species in Appendix 8. Based on these assessments it was considered that the proposed upgrade was unlikely to have a significant impact on any of the threatened and/or migratory species with potential habitat within the study area, given the extent of similar habitats within the local area and the small area to be directly impacted. However, it is recommended that where possible potential habitat features such as tree hollows be avoid and suitable mitigation measures such as sedimentation controls, be implemented during the construction and operational phases.

No critical habitat listed on the EPBC Act will be impacted by the proposed upgrade.

7.0 OVERALL IMPACT ASSESSMENT

In summary, the impact assessments under both the TSC and EPBC Acts undertaken for potentially impacted threatened plants, animals and ecological communities concluded that the proposed upgrade would have a minimal impact on threatened biota in the local area, given that:

- Existing habitats within the study area are highly fragmented and isolated and this would not be greatly increased by the proposed upgrade.
- A small amount of threatened species habitat will be removed by the proposed upgrade compared to larger areas of similar habitat types occurring in the Locality.
- The habitats in the study area are already highly modified due to the small size, fragmentation and existing edge effects and weed invasion. The proposed upgrade is not likely to further signficiantly alter the condition of the habitats in the study area.

The implementation of suitable mitigation measures during the design, construction and operational phases of the proposed upgrade would reduce impacts on threatened and migratory species such that the action is likely to have a minimal impact. A referral to DEWHA is not recommended.

7.1 Key Thresholds under the Part 3A of the Environmental Planning & Assessment Act 1979

The Part 3A Guidelines of the EP&A Act (DEC & DPI 2005) set out a number of key thresholds which need to be addressed to justify the impacts of the proposal on threatened species, populations or ecological communities. The key thresholds are (DEC & DPI 2005):

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

The proposed upgrade is justified in terms of maintaining biodiversity values, given that:

- The proposed upgrade avoids significant areas of habitat and known threatened species locations.
- The proposed upgrade would not greatly increase fragmentation of existing habitats. Further, mitigation measures such as fauna crossing structures, will reduce the impact of habitat fragmentation.

- The habitats in the study area are already highly modified. The proposed upgrade is not likely to further signficiantly alter the condition of the habitats in the study area.

- The proposed upgrade removes 2.0 ha of native vegetation that needs to be compensated for in consultation with DECC.

Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

The proposed upgrade will result in the direct removal of a few individuals of some threatened plant species (one *Syzygium moorei*, one *Tinospora tinosporoides* and two planted individuals of *Diploglottis campbellii*, see Table 11). However, these species occur in numerous locations in the Locality, and the removal of a few individials is not likely to reduce the long term viability of these threatened species.

The proposal will also result in the removal and/or modification of a small area of potential habitat for threatened flora and fauna. Impacts to threatened species are considered to be relatively minor given the extent of similar habitats within the local area and the small area to be directly impacted.

Approximately 2.0 ha of Lowland Rainforest would be impacted by the proposed upgrade. Considering the poor quality of this community within the study area and the small area to be cleared by the proposed upgrade, the proposed upgrade is not likely to significantly impact the long-term viability of Lowland Rainforest.

The proposed upgrade is justified as it is not likely to reduce the long term viability of a local population of a species, population or ecological community.

Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.

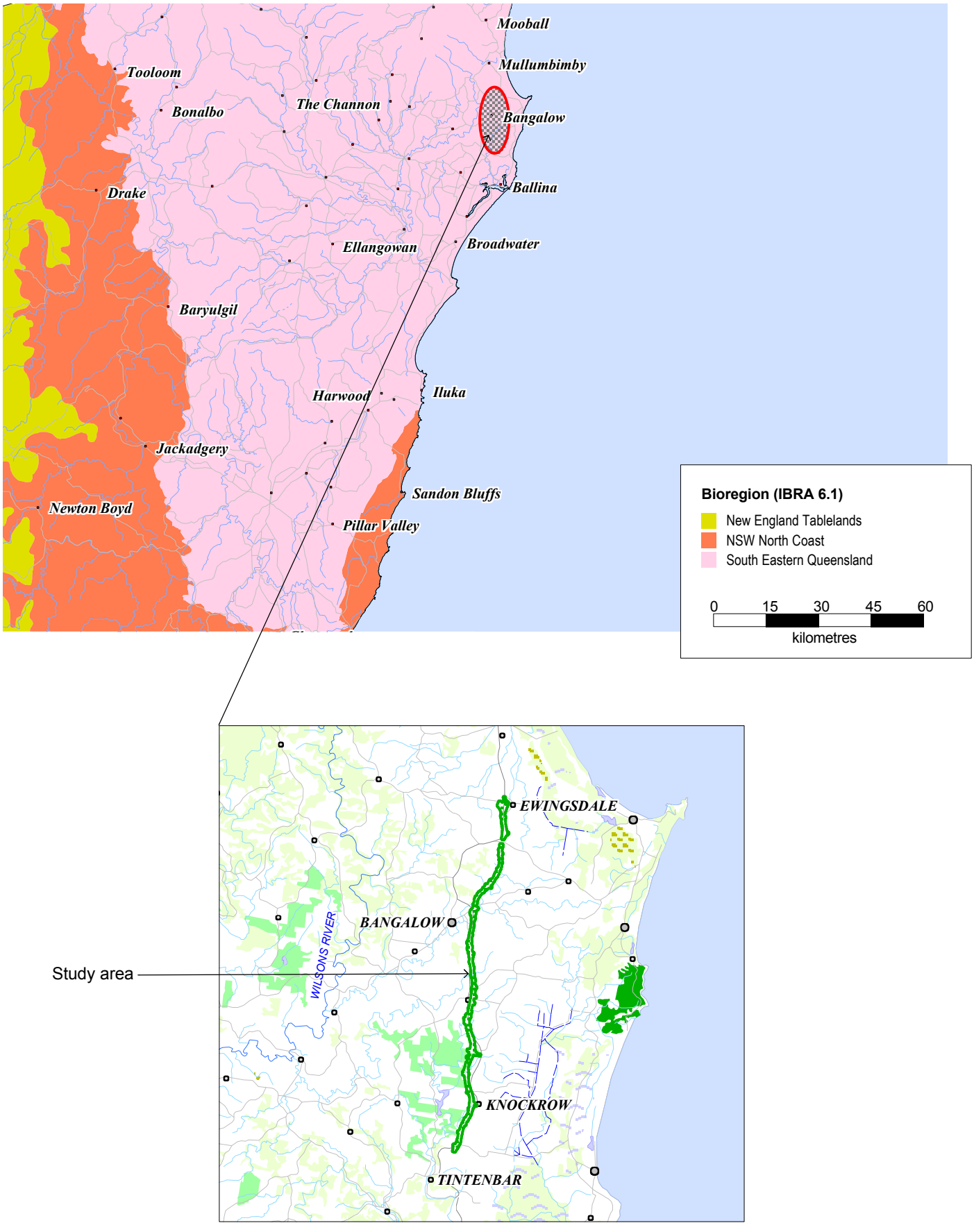
Impacts to threatened species, populations and ecological communities are considered to be relatively minor given the extent of similar habitats within the local area and the small area to be directly impacted.

The proposed upgrade is justified as it is considered unlikely to accelerate the extinction of a threatened species, population or ecological community.

Whether or not the proposal will adversely affect critical habitat.

The proposed upgrade is justified as it will not impact on any areas identified as critical habiat under the TSC and/or EPBC Act.

FIGURES



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15 - 17 Henrietta Street
Chippendale
NEW SOUTH WALES 2008

Figure 1: Location of the Study Area in a regional context.

DATE: 26 Oct 07 | Checked: SEW | File: S4071

Location:-.4000\4000s\4071\S4071 EIS \Mapping\S4071 F1_locality.WOR

Scale: 0 2.5 5.0 7.5 10 kilometres

N W E S

EWINGSDALE

ST HELENA

BANGALOW

BINNA BURRA

NEWRYBAR

FERNLEIGH

KNOCKROW

TYUMBA

LENNOX HEAD

Key

Route concept

Buffer zone

Acknowledgements: ARUP
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Figure 2: Route concept and 50m buffer zone.

DATE: 26 October 2007

Checked by: RH | File number: S4071

Location:-..\4000\4000s\4071\4071 EIS\Mapping\S4071 F2_buffer.WOR

Scale: 0 0.5 1.0 1.5 2.0 2.5 kilometres

N W E S

Key

Study Area

Vegetation communities

- Camphor laurel
- Freshwater Wetland
- Lowland Rainforest
- Lowland Rainforest on Floodplain
- Moist Sclerophyll Forest
- Not surveyed - outside study area
- Plantation
- Swamp Sclerophyll Forest

Constraint class

- EEC
- Very High
- High
- Medium
- Low
- Key vegetation patch

Threatened species records

Plant species

- *Acalypha eremorum*
- *Archidendron hendersonii*
- *Arthraxon hispidus*
- *Cryptocarya foetida*
- *Davidsonia jerseyana*
- *Davidsonia johnsonii*
- *Diploglottis campbellii*
- *Endiandra hayesii*
- *Gossia fragrantissima*
- *Isoglossa eranthemoides*
- *Macadamia tetraphylla*
- *Ochrosia moorei*
- *Syzygium hodgkinsoniae*
- *Syzygium moorei*
- *Syzygium paniculatum*
- *Tinospora tinosporoides*

Animal species

- Black Flying-fox
- Black-necked Stork
- Brolga
- Common Planigale
- Eastern Freetail-bat
- Grass Owl
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Koala
- Little Bentwing-bat
- Rose-crowned Fruit-Dove
- White-eared Monarch

Wildlife corridors

- DECC corridor
- Byron Bay Council

Patch 1

Patch 2

Patch 3

Patch 4

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Figure 3a: Constraints mapping, showing plant communites and locations of threatened species - Ewingsdale/Bangalow section.

DATE: 21 December 2007

Checked by: RH | File number: S4071

Location:-...4000\4000s\4071\4071 EA\Mapping\S4071 F3a_constraints.WOR

Scale: 0 0.2 0.4 0.6 0.8 1.0 kilometres

N W E S

Key

Study Area

Vegetation communities

- Camphor laurel
- Freshwater Wetland
- Lowland Rainforest
- Lowland Rainforest on Floodplain
- Moist Sclerophyll Forest
- Not surveyed - outside study area
- Plantation
- Swamp Sclerophyll Forest

Constraint class

- EEC
- Very High
- High
- Medium
- Low
- Key vegetation patch

Threatened species records

Plant species

- *Acalypha eremorum*
- *Archidendron hendersonii*
- *Arthraxon hispidus*
- *Cryptocarya foetida*
- *Davidsonia jerseyana*
- *Davidsonia johnsonii*
- *Diploglottis campbellii*
- *Endiandra hayesii*
- *Gossia fragrantissima*
- *Isoglossa eranthemoides*
- *Macadamia tetraphylla*
- *Ochrosia moorei*
- *Syzygium hodgkinsoniae*
- *Syzygium moorei*
- *Syzygium paniculatum*
- *Tinospora tinosporoides*

Animal species

- Black Flying-fox
- Black-necked Stork
- Brolga
- Common Planigale
- Eastern Freetail-bat
- Grass Owl
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Koala
- Little Bentwing-bat
- Rose-crowned Fruit-Dove
- White-eared Monarch

Wildlife corridors

- DECC corridor
- Byron Bay Council

Patch 3
Patch 4
Patch 5
Patch 6
Patch 7
Patch 8
Patch 9
Patch 10

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Figure 3b: Constraints mapping, showing plant communites and locations of threatened species - Coopers Shoot/Emigrant Creek section.

DATE: 21 December 2007

Checked by: RH | File number: S4071

Location:-...4000\4000s\4071\4071 EA\Mapping\S4071 F3b_constraints.WOR

Scale: 0 0.2 0.4 0.6 0.8 1.0 kilometres

N W E S

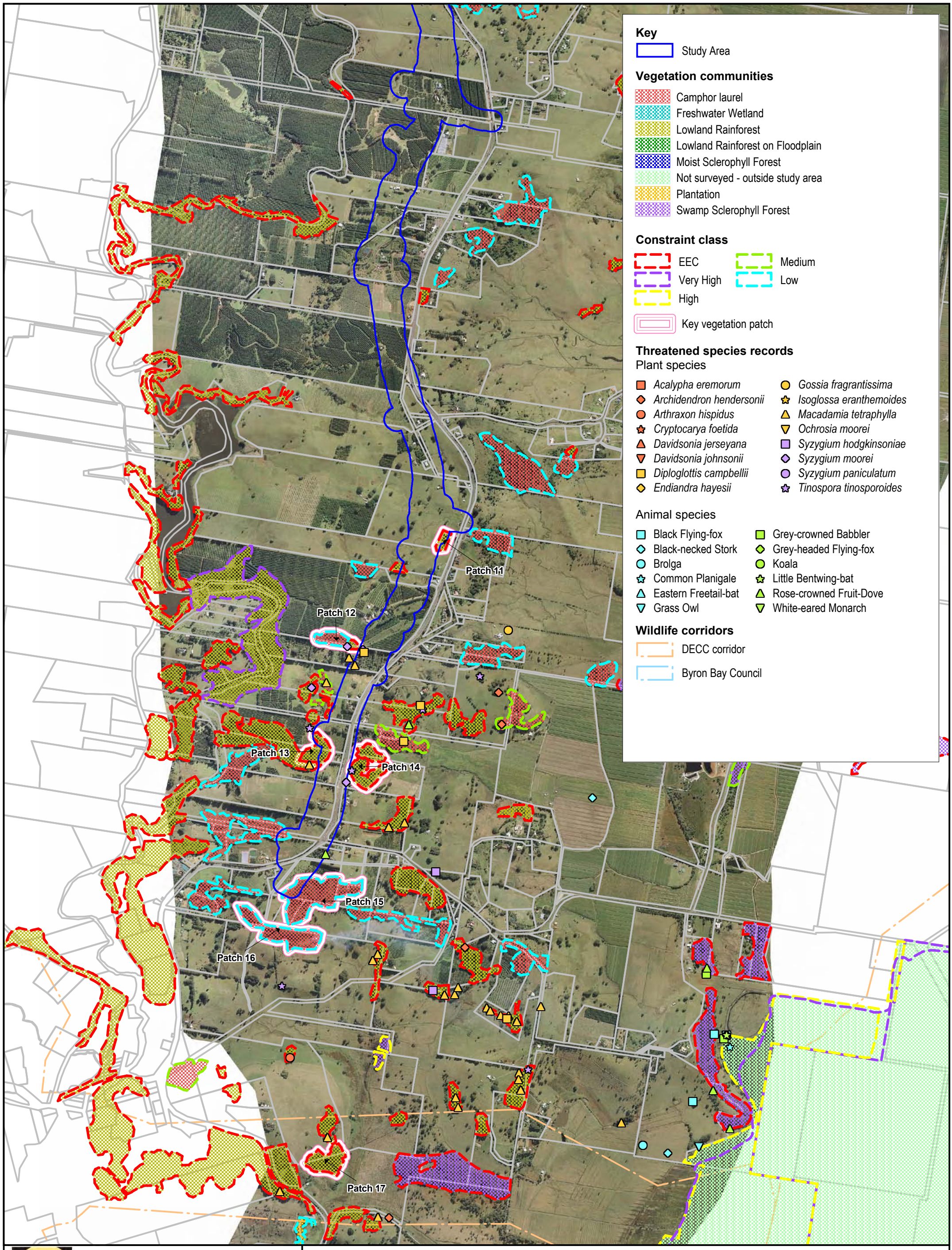

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Figure 3c: Constraints mapping, showing plant communites and locations of threatened species - Newrybar Swamp/Tintenbar section.

DATE: 21 December 2007

Checked by: RH | File number: S4071

Location:-...4000\4000s\4071\4071 EA\Mapping\S4071 F3c_constraints.WOR

Scale: 0 0.2 0.4 0.6 0.8 1.0 kilometres

N W E S

EWINGSDALE

WILSONS RIVER

BANGALOW

Threatened plant species

- *Acacia bakeri*
- *Acalypha eremorum*
- *Acronychia littoralis*
- *Allocasuarina defungens*
- *Amorphospermum whitei*
- *Archidendron hendersonii*
- *Arthraxon hispidus*
- *Chamaesyce psammogeton*
- *Corokia whiteana*
- *Cryptocarya foetida*
- *Davidsonia jerseyana*
- *Davidsonia johnsonii*
- *Desmodium acanthocladum*
- *Diploglottis campbellii*
- *Diuris sp. aff. chrysantha*
- *Drynaria rigidula*
- *Elaeocarpus williamsianus*
- *Endiandra floydii*
- *Endiandra hayesii*
- *Endiandra muelleri subsp. bracteata*
- *Floydia praealta*
- *Fontainea oraria*
- *Geodorum densiflorum*
- *Gossia fragrantissima*
- *Grevillea hilliana*
- *Hibbertia hexandra*
- *Hicksbeachia pinnatifolia*
- *Isoglossa eranthemoides*
- *Macadamia tetraphylla*
- *Marsdenia longiloba*
- *Melicope vitiflora*
- *Ochrosia moorei*
- *Owenia cepiodora*
- *Peristeranthus hillii*
- *Phaius australis*
- *Phaius tankarvilleae*
- *Phyllanthus microcladus*
- *Pterostylis nigricans*
- *Randia moorei*
- *Senna acclinis*
- *Sophora fraseri*
- *Syzygium hodgkinsoniae*
- *Syzygium moorei*
- *Syzygium paniculatum*
- *Tinospora tinosporoides*
- *Xylosma terrae-reginae*

Key

- Study Area
- 10km search area

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Figure 4a: Threatened plant species previously recorded within 10km of the Study Area, as derived from the DECC Altas of NSW Wildlife, Byron and Ballina Council records, property owner records and records from this study

DATE: 13 March 2008

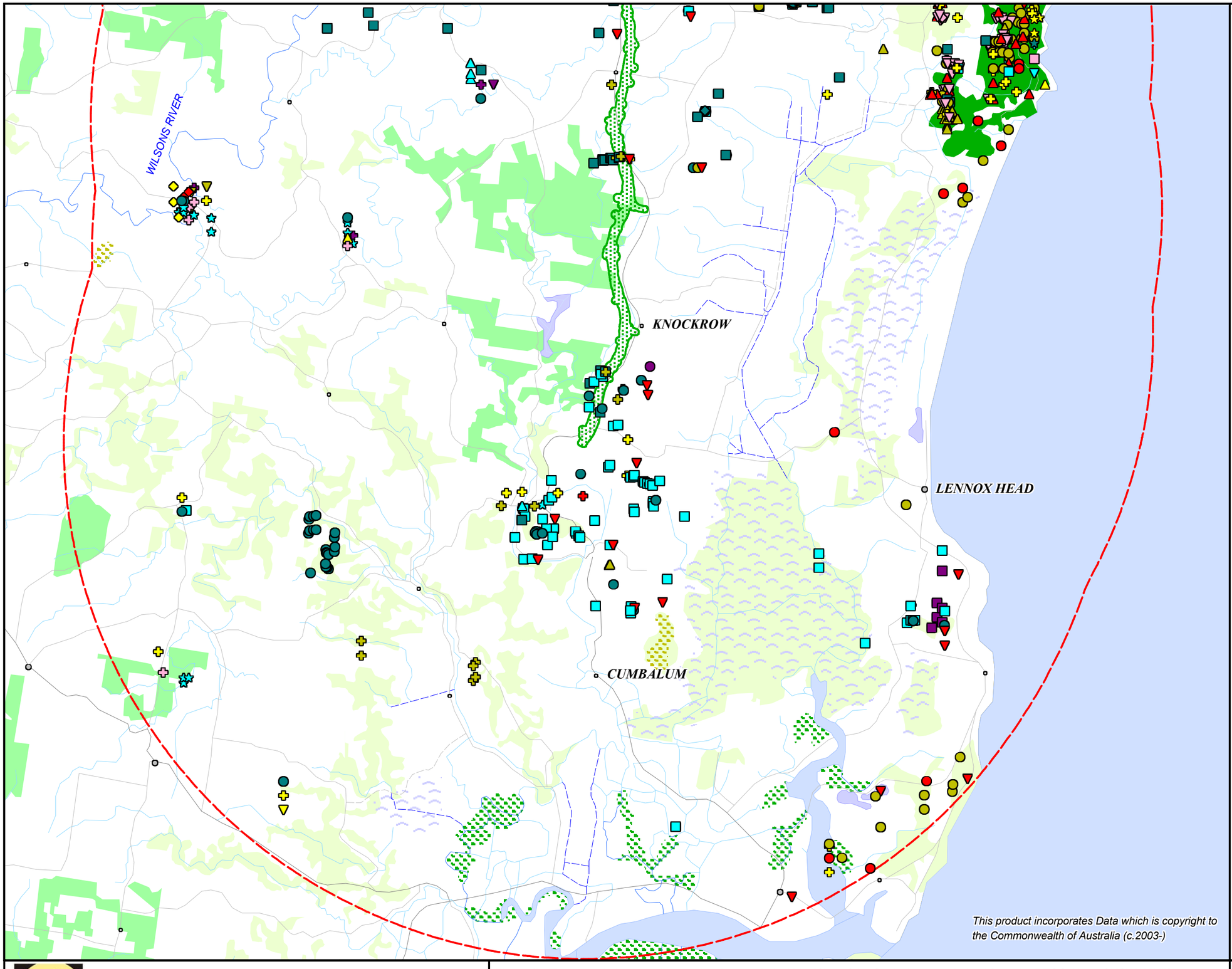
Checked by: SEW | File number: S4071

Location:-..4000\4000s\4071\S4071 EIS\Mapping\S4071 F4_flora.WOR

Scale: 0 0.75 1.5 2.25 3.0 3.75 kilometres

N W E S

Figure 4a: Threatened plant species previously recorded within 10km of the Study Area.



Threatened plant species

- *Acacia bakeri*
- *Acalypha eremorum*
- *Acronychia littoralis*
- *Allocasuarina defungens*
- *Amorphospermum whitei*
- *Archidendron hendersonii*
- *Arthraxon hispidus*
- *Chamaesyce psammogeton*
- *Corokia whiteana*
- *Cryptocarya foetida*
- *Davidsonia jerseyana*
- *Davidsonia johnsonii*
- *Desmodium acanthocladum*
- *Diploglottis campbellii*
- *Diuris sp. aff. chrysantha*
- *Drynaria rigidula*
- *Elaeocarpus williamsianus*
- *Endiandra floydii*
- *Endiandra hayesii*
- *Endiandra muelleri subsp. bracteata*
- *Floydia praealta*
- *Fontainea oraria*
- *Geodorum densiflorum*
- *Gossia fragrantissima*
- *Grevillea hilliana*
- *Hibbertia hexandra*
- *Hicksbeachia pinnatifolia*
- *Isoglossa eranthemoides*
- *Macadamia tetraphylla*
- *Marsdenia longiloba*
- *Melicope vitiflora*
- *Ochrosia moorei*
- *Owenia cepiodora*
- *Peristeranthus hillii*
- *Phaius australis*
- *Phaius tankarvilleae*
- *Phyllanthus microcladus*
- *Pterostylis nigricans*
- *Randia moorei*
- *Senna acclinis*
- *Sophora fraseri*
- *Syzygium hodgkinsoniae*
- *Syzygium moorei*
- *Syzygium paniculatum*
- *Tinospora tinosporoides*
- *Xylosma terrae-reginae*

Key

- Study Area
- 10km search area

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Figure 4b: Threatened plant species previously recorded within 10km of the Study Area, as derived from the DECC Altas of NSW Wildlife, Byron and Ballina Council records, property owner records and records from this study

DATE: 13 March 2008

Checked by: SEW | File number: S4071

Location:-..4000\4000s\4071\S4071 EIS\Mapping\S4071 F4_flora.WOR

Scale: 0 0.75 1.5 2.25 3.0 3.75 kilometres

N W E S

Figure 4b: Threatened plant species previously recorded within 10km of the Study Area.

MULLUMBIMBY

EWINGSDALE

BANGALOW

WILSONS RIVER

Legend

Threatened animal species

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Beach Stone-curlew
- Black Bittern
- Black Flying-fox
- Black-necked Stork
- Black-tailed Godwit
- Black-winged Petrel
- Broad-billed Sandpiper
- Brolga
- Bush Stone-curlew
- Bush-hen
- Collared Kingfisher
- Comb-crested Jacana
- Common Blossom-bat
- Common Planigale
- Diamond Firetail
- Double-eyed Fig-parrot
- Dugong
- Eastern Bentwing-bat
- Eastern Chestnut Mouse
- Eastern Freetail-bat
- Eastern Ground Parrot
- Eastern Long-eared Bat
- Eastern Tube-nosed Bat
- Flesh-footed Shearwater
- Freckled Duck
- Glossy Black-Cockatoo
- Gould's Petrel
- Grass Owl
- Great Knot
- Greater Broad-nosed Bat
- Greater Sand-plover
- Green and Golden Bell Frog
- Green Turtle
- Grey Ternlet
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Humpback Whale
- Kermadec Petrel
- Koala
- Large-footed Myotis
- Leathery Turtle
- Lesser Sand-plover
- Little Bentwing-bat
- Little Shearwater
- Little Tern
- Loggerhead Turtle
- Long-nosed Potoroo
- Magpie Goose
- Mangrove Honeyeater
- Marbled Frogmouth
- Masked Owl
- Mitchell's Rainforest Snail
- Northern Giant-Petrel
- Olongburra Frog
- Osprey
- Painted Snipe
- Pied Oystercatcher
- Pouched Frog
- Providence Petrel
- Red Goshawk
- Red-tailed Tropicbird
- Rose-crowned Fruit-Dove
- Sanderling
- Sooty Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Giant Petrel
- Spotted-tailed Quoll
- Square-tailed Kite
- Superb Fruit-Dove
- Terek Sandpiper
- Wallum Froglet
- White Tern
- White-eared Monarch
- Wompoo Fruit-Dove

Survey Areas

Study Area

10km search area

BIOSIS RESEARCH Pty. Ltd.

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Chippendale
NEW SOUTH WALES 2008

Figure 5a: Threatened animal species previously recorded within 10km of the Study Area, as derived from the DECC Altas of NSW Wildlife, Byron and Ballina Council records, property owner records and records from this study

Figure 5a: Threatened animal species previously recorded within 10km of the Study Area.

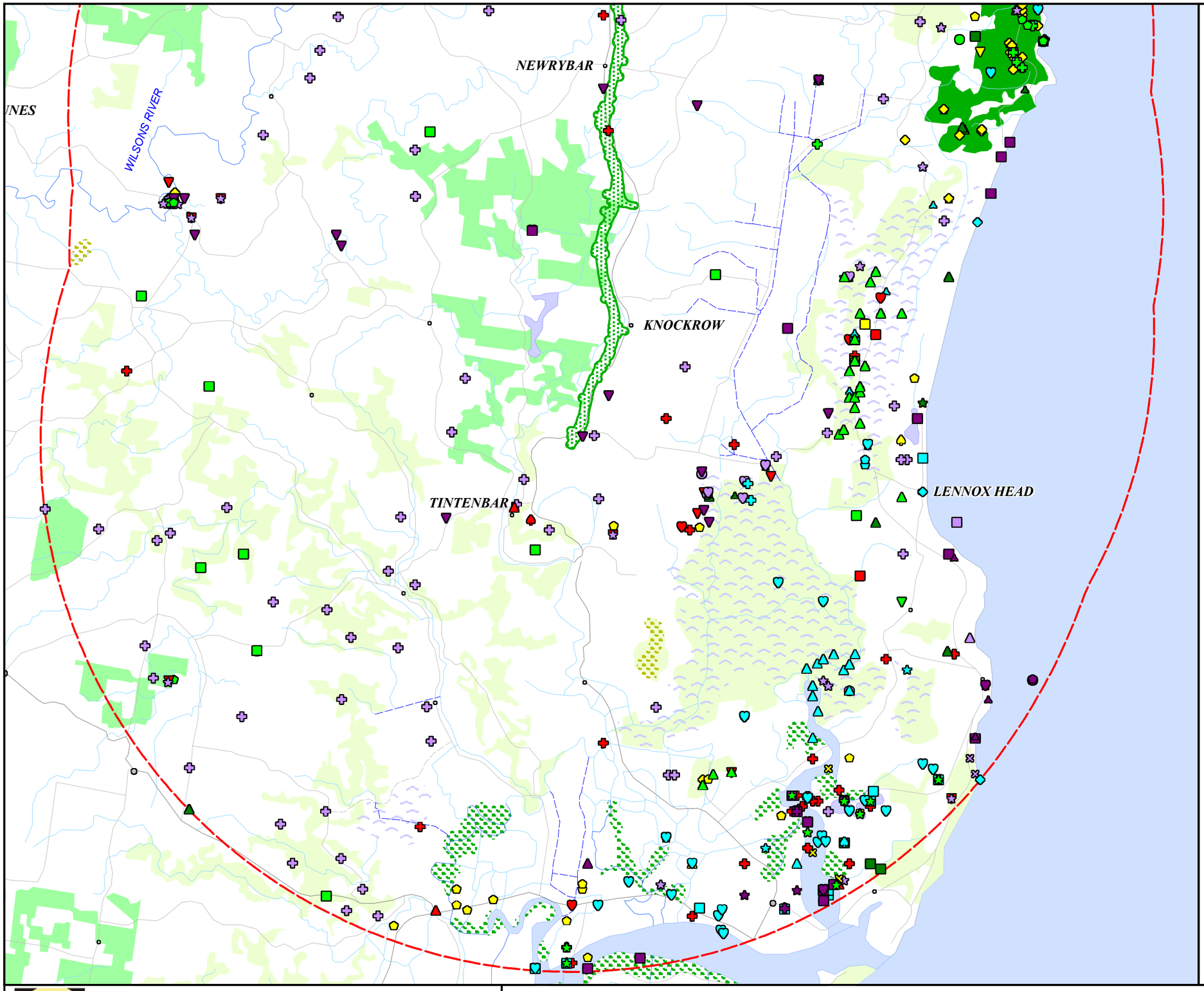
DATE: 14 March 2008

Checked by: SEW | File number: S4071

Location:-..4000\4000s\4071\S4071 EIS\Mapping\S4071 F5_fauna.WOR

Scale: 0 0.75 1.5 2.25 3.0 3.75 kilometres

N W E S



Legend

Threatened animal species

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Beach Stone-curlew
- Black Bittern
- Black Flying-fox
- Black-necked Stork
- Black-tailed Godwit
- Black-winged Petrel
- Broad-billed Sandpiper
- Brolga
- Bush Stone-curlew
- Bush-hen
- Collared Kingfisher
- Comb-crested Jacana
- Common Blossom-bat
- Common Planigale
- Diamond Firetail
- Double-eyed Fig-parrot
- Dugong
- Eastern Bentwing-bat
- Eastern Chestnut Mouse
- Eastern Freetail-bat
- Eastern Ground Parrot
- Eastern Long-eared Bat
- Eastern Tube-nosed Bat
- Flesh-footed Shearwater
- Freckled Duck
- Glossy Black-Cockatoo
- Gould's Petrel
- Grass Owl
- Great Knot
- Greater Broad-nosed Bat
- Greater Sand-plover
- Green and Golden Bell Frog
- Green Turtle
- Grey Ternlet
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Humpback Whale
- Kermadec Petrel
- Koala
- Large-footed Myotis
- Leathery Turtle
- Lesser Sand-plover
- Little Bentwing-bat
- Little Shearwater
- Little Tern
- Loggerhead Turtle
- Long-nosed Potoroo
- Magpie Goose
- Mangrove Honeyeater
- Marbled Frogmouth
- Masked Owl
- Mitchell's Rainforest Snail
- Northern Giant-Petrel
- Olongburra Frog
- Osprey
- Painted Snipe
- Pied Oystercatcher
- Pouched Frog
- Providence Petrel
- Red Goshawk
- Red-tailed Tropicbird
- Rose-crowned Fruit-Dove
- Sanderling
- Sooty Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Giant Petrel
- Spotted-tailed Quoll
- Square-tailed Kite
- Superb Fruit-Dove
- Terek Sandpiper
- Wallum Froglet
- White Tern
- White-eared Monarch
- Wompoo Fruit-Dove

Survey Areas

- Study Area
- 10km search area

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Figure 5b: Threatened animal species previously recorded within 10km of the Study Area, as derived from the DECC Altas of NSW Wildlife, Byron and Ballina Council records, property owner records and records from this study

Figure 5b: Threatened animal species previously recorded within 10km of the Study Area.

DATE: 14 March 2008

Checked by: SEW | File number: S4071

Location:-..4000\4000s\4071\S4071 EIS\Mapping\S4071 F5_fauna.WOR

Scale: 0 0.75 1.5 2.25 3.0 3.75 kilometres

N W E S

EWINGSDALE

BYRON

Cumbebin Swamp - Tyagarah

Wilsons

Hayters

Wilsons River

BANGALOW

BINNA BURRA

Hogans

Broken Head

NEWRYBAR

KNOCKROW

Newrybar 1

FERNLEIGH

TYUMBA

DECC wildlife corridor classes

- Regional
- Subregional

Byron Council wildlife corridor classes

- Regional
- Subregional
- Undefined

Key

- SEPP14 wetland
- Study Area

Acknowledgements: DECC and Byron Bay Council

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NEW SOUTH WALES 2008

Figure 6: Regional key habitat and corridors and SEPP14 Wetlands.

DATE: 23 August 2007

Checked by: RH | File number: S4071

Location:-..\4000\4000s\4071\4071 EIS\Mapping\S4071 F6_corridors.WOR

Scale: 0 0.5 1.0 1.5 2.0 2.5 kilometres

N W E S

APPENDICES

Appendix 1
Summary of Qualifications and Experience of Survey Members

This appendix details the qualifications and experience of team members involved in the survey work.

RHIDIAN HARRINGTON — CURRICULUM VITAE

POSITION:

Sydney Resource Group Manager/Senior Ecologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Birds Australia
Birds Australia Southern NSW and ACT (BASNA) committee member
Ecological Society of Australia
Environmental Institute of Australia and New Zealand (EIANZ)

QUALIFICATIONS:

Bachelor of Science (Hons), James Cook University
Masters Science (Zoology), University of the Witwatersrand
Doctor of Philosophy (Zoology), University of Melbourne

EMPLOYMENT PROFILE:

2006-	Sydney Resource Group Manager, Biosis Research Pty. Ltd.
2003-2006	Senior Ecologist, Biosis Research Pty. Ltd.
2002-03	Project Officer, Black-eared Miner Recovery Team, La Trobe University, Melbourne
2002	Scientific writer, Institute of Land and Food Resources (ILFR), University of Melbourne
1998-01	Research coordinator/demonstrator, Melbourne University
1998-02	Research Assistant, Puckapunyal Army Reserve, Victoria
1995-96	Research assistant, Botswana National Parks
1993-95	Lecturer/Demonstrator, University of the Witwatersrand, South Africa
1992	Research assistant for OTC and National Parks Queensland, Australia
1992	Research assistant, Australian Centre for Tropical and Freshwater Research, Queensland
1987	Volunteer research assistant, National Park and Wildlife Service, Zimbabwe

FIELDS OF COMPETENCE:

- ✓ Terrestrial ecology
- ✓ Zoology
- ✓ Flora and fauna survey and identification
- ✓ Identification of Australian vertebrates
- ✓ Native vegetation classification and mapping
- ✓ Literature reviews
- ✓ Experimental design
- ✓ Expert evidence
- ✓ Statistical data analysis
- ✓ Environmental impact assessment
- ✓ Impact minimisation (mitigation) guidelines
- ✓ GIS mapping
- ✓ Project management

PROFESSIONAL EXPERIENCE:

Rhidian has over 14 years experience in applied conservation biology and consulting. A sample of key professional experience is presented below.

Zoologist, providing expert advice on Black-throated Finch for proposed Rocky Springs

development, Townsville (*2008-present for Bovis Lend Lease)*

Zoologist, flora and fauna assessment for modifications to the Ballina Bypass (*2007-08 for Ballina Bypass alliance*)

Zoologist/QA, flora and fauna assessment for Tomago Aliminium Smelter expansion project (*2008 for TransGrid*)

Expert witness/Zoologist, acted as an expert witness in the Land and Environment Court for the proposed Gerroa Sand Mine extension, Gerroa (*2007-08 for Sparke Helmore Lawyers*)

Zoologist/QA, Species Impact Statement for proposed extension of Cessnock Waste Facility (*2007-08 for National Environmental Consulting Services)*

Zoologist, providing expert advice for proposed Hunter Economic Zone development, Kurri Kurri (*2007-present for Hunter Economic Zone)*

Zoologist, providing expert advice on Black-throated Finch for proposed Rocky Springs development, Townsville (*2007 for Lancashire General Investments)*

Zoologist, targeted surveys and Species Impact Assessment for threatened species, Dendrobium Area 3 (*2006-07 for BHP Billiton Illawarra Coal*)

Zoologist, Avifauna assessment for a proposed wind farm at Vacy, NSW (*2006 for Green Power Pty. Ltd.*)

Project Manager/Ecologist, Expert advice for landscape works at Newington Armoury, Sydney Olympic Park (*2007 for the Government Architects Office*)

Zoologist, flora and fauna assessment for proposed Woy Woy Road interchange (*2007 for Arup and the RTA*)

Project Manager/Ecologist, expert advice at workshop for developing mitigation measures for linear infrastructure (*2007 for Department of the Environment and Water Resources*)

Zoologist, Green and Golden Bell Frog Management and Corridor Design at Blaxland Common, Sydney Olympic Park (*2006 for Sydney Olympic Park Authority*)

Project Manager/Ecologist, targeted surveys and Species Impact Statement for the proposed electricity adjustments associated with the F3 to Branxton Link (*2006-08 for the RTA and Enerserve*)

Zoologist, flora and fauna assessment of Ballina Bypass modifications (*2007 for Arup and the RTA*)

Zoologist, Flora and fauna impact assessment for decommissioning and rehabilitation of Elouera Colliery (*2006-2007 for BHP Billiton Illawarra Coal*)

Project Manager/Ecologist, Targeted surveys for microchiropteran bats and impact assessment for threatened species for the proposed electricity adjustments associated with the F3 to Branxton Link (*2006-2007 for the RTA and Enerserve*)

Zoologist, Targeted surveys and impact assessment for threatened animal species for the proposed West Cliff coal wash emplacement, Area 3 (*2006-07 for BHPBilliton*)

Zoologist/Expert Advice, for the critical review of flora and fauna documentation for the North Beach Byron tourist development, *(2006 for Department of Planning)*

Project Manager/Ecologist, Route option assessment and targeted surveys and impact assessment for threatened species for proposed Pacific Highway Upgrade: Woodburn to Ballina (*2006-present for Hyder Consulting and the RTA*)

Project Manager/Ecologist, baseline flora and fauna survey and assessment of environmental buffers of the Northern Exploration Drilling Area (Palm Creek), Weipa region, Queensland (*2005 for Comalco Weipa*)

Zoologist, impact assessment of subsidence on threatened animal species for the proposed West Cliff Colliery Area 5 - longwalls 31-33, Appin, NSW (*2005 for BHPBilliton*)

Zoologist, Monitoring of frogs, reptiles and birds at Hartley Quarry (*2005-present for RW Corkery & Co*)

Zoologist, Targeted surveys and impact assessment for threatened species (Mallee Emuwren and Long-eared Bat) for the proposed Long Term Containment Facility, Nowingi, Victoria (*2005 for Major Projects Victoria*)

Project Manager/Ecologist, Targeted surveys and impact assessment for threatened species for proposed electricity adjustments associated with the National Highway Link F3 to Branxton, Kurri Kurri region, NSW (*2005 for Energy Australia and the RTA*)

Project Manager/Ecologist, Constraints assessment, route option assessment and targeted surveys and impact assessment for threatened species for the proposed Pacific Highway Upgrade: Tintenbar to Ewingsdale (*2004-present for Arup and the NSW Roads and Traffic Authority*)

Project Manager/Ecologist, Targeted surveys and impact assessment for threatened species for proposed modifications to a High Pressure Gas Pipeline, Stockrington Road, near Seahampton, NSW (*2004 for GHD and the RTA*)

Project Manager/Ecologist, Targeted surveys and impact assessment for threatened species for proposed modifications to the South Maitland Railway, Kurri Kurri (*2004 for the RTA*)

Project Manager/Ecologist, Targeted surveys for Koala and Yellow-bellied Glider and impact assessment for threatened species for the proposed Oxley Highway Upgrade, Port Macquarie (*2004-present for the RTA*)

Project Manager/Ecologist, Review of detailed road design in collaboration with road engineers to reduce impacts on threatened flora and fauna on the proposed National Highway Link F3 to Branxton (*2004-present for the RTA*)

Project Manager/Ecologist, Design of mitigation measures for threatened flora and fauna impacted by the proposed National Highway Link F3 to Branxton (*2004-present for the RTA*)

Project Manager/Ecologist, Translocation assessment for threatened flora and fauna impacted by the proposed National Highway Link F3 to Branxton (*2004-05 for the RTA*)

Ecologist, Targeted surveys and impact assessment for threatened species for the proposed Pacific Highway Upgrade, Moorlands to Herons Creek (*2004-2006 for Arup and the RTA*)

Project Manager/Ecologist, Targeted surveys and impact assessment for threatened species for the proposed modifications to the *National Highway Link F3 to Branxton (2004 for the RTA*)

Project Manager/Ecologist, Targeted surveys for *Tetratheca juncea* and *Cryptostylis hunteriana* for the proposed F3 Freeway to Branxton Geotechnical Variation. (*2004 for the RTA)*

Ecologist, survey and statistical design to measure the impacts of mine subsidence for the Dendrobium Coal Project (*2004 for BHPBilliton*)

Project Manager/Ecologist, Targeted surveys for threatened avifauna and habitat along the Darling Anabranch and a proposed pipeline (*2003-2004 for NSW Department of Infrastructure, Planning and Natural Resources)*

Project Manager/Ecologist, Habitat assessment and eight part tests for threatened species along the Darling Anabranch. (*2003-2004 for NSW Department of Infrastructure, Planning and Natural Resources)*

Project Manager/Ecologist, Targeted surveys and eight part tests for threatened species for the proposed National Highway Link F3 to Branxton (*2003 for the RTA*)

Project Officer, Black-eared Miner Recovery Team (*2002-2003 for La Trobe University, Melbourne*)

Scientific Writer, Institute for Land and Food Resources (ILFR) (*2002 for the University of Melbourne*)

Project Manager/Zoologist, Environmental Baseline Survey of Khirthar National Park, Pakistan, (*2000-2001 for Premier-Shell and the Sindh Wildlife Department, Pakistan*)

Chief Investigator, studying the impacts of artificial water points on avifaunal distribution and abundance in the arid mallee habitat of southeast Australia (*1998-2002 for Birds Australia*)

Research Assistant, Kangaroo Census Team, Puckapunyal Army Reserve, Victoria (*1998-2002 for the Department of Defence*)

Research Assistant, aerial and ground census, wildlife monitoring and data analysis (*1995-1996 for the National Parks Service, Botswana*)

Chief Investigator, determining the causes of the roan antelope decline in Kruger National Park, South Africa (*1993-1995 for the National Parks Service, South Africa)*

Lecturer in Ecology, teaching and coordinating ecology and conservation biology for first year students (*1995 for the University of the Witwatersrand, South Africa*)

Research Assistant, fauna survey of Prudhoe Island Queensland (*1992 for OTC and Queensland National Parks*)

Chief Investigator, studying the importance of riparian vegetation to avifauna in the tropical

woodlands of north Queensland (*1992 for James Cook University*)

Research Assistant, fauna surveys of the Burdekin River Floodplains, Queensland (*1992 for Australian Centre for Tropical and Freshwater Research*)

Research Assistant, research into savanna ecology, including soil erosion, and the management of Hwange National Park (*1987 for the National Parks Service, Zimbabwe*)

PUBLICATIONS:

Rhidian has been involved in the publishing of over 40 consultant reports and the following scientific papers.

Harrington, R. 2003. The distribution and abundance of avifauna around artificial watering points in the arid and semi-arid mallee environments of southeast Australia. Journal of Arid Environments (in prep.).

Harrington, R. 2003. Changes in vegetation structure and soil characteristics around artificial watering points in the arid mallee of southeast Australia. Journal of Arid Environments (in prep.).

Harrington, R. 2003. Patterns of water utilisation by avifauna in an arid mallee environment. Emu (in prep.).

Harrington, R. & Morgan, D.G. 2003. The relationship between vegetation structure and floristics, avifauna and distance to water in an arid mallee system. Austral Ecology (in prep.).

Harrington, R., Ballentine, M. & Morgan, D.G. 2003. The relationships between changes in vegetation floristics and herbivore diets around artificial watering points in the arid mallee of southeast Australia. Rangeland Journal (in prep.).

Yamada, K., Ansari, M., **Harrington, R.**, Morgan, D. and Burgman, M.A. 2004. Sindh Ibex (*Capra aegagrus blythi*) in Kirthar National Park, Pakistan: Sensitivity of a Habitat and Population Model. In: H.R. Akçakaya, M.A. Burgman, O. Kindvall, C.C. Wood, P. Sjögren-Gulve, J.S. Hatfield and M.A. McCarthy (Eds), *Species Conservation and Management: Case Studies*, pp 469-481. Oxford University Press, New York.

Harrington, R., Owen-Smith, N., Viljoen, P.C., Biggs, H.C, Mason, D.R. & Funston, P. 1999. Establishing the causes of the roan antelope decline in Kruger National Park, South Africa. Conservation Biology 90: 69 - 78.

TERRI-ANN ENGLISH CURRICULUM VITAE

POSITION:

Zoologist, Biosis Research Pty. Ltd.

QUALIFICATIONS:

Bachelor of Applied Science (Environmental Science) Charles Sturt University, Wagga Wagga
Currently undertaking Masters in Environmental Science at University of Western Sydney

CERTIFICATES:

Senior First Aid Certificate – St John Ambulance, January 2006.
OHS Construction Induction (Green Card) – Work Cover NSW, December 2006.

EMPLOYMENT PROFILE:

2001 – Current	Zoologist, Biosis Research Pty. Ltd.
1999 – 01	Zoologist/Technical Assistant, Biosis Research Pty. Ltd.
1996	Technical Officer Scientific NSW NPWS

FIELDS OF COMPETENCE:

- ✓ fauna survey
- ✓ mammalian fauna research
- ✓ frog surveys
- ✓ bird surveys
- ✓ habitat and biodiversity assessment
- ✓ rare and threatened species assessment
- ✓ project management, research, data analysis and report preparation
- ✓ environmental impact statement – natural environment
- ✓ impact minimisation (mitigation) guidelines

PROFESSIONAL EXPERIENCE:

Terri has seven years experience in applied conservation ecology and consulting. A sample of key professional experience at Biosis Research is presented below.

Project manager/Zoologist, Terrestrial flora and fauna habitat assessment of Delta Longwalls 11 - 19 to assess potential impacts of subsidence (*Delta Mining*).

Project manager/Zoologist, Terrestrial flora and fauna habitat assessment of Gas pipeline from Appin to West Cliff mine, Appin (Olsen Environmental Consulting).

Project manager/Zoologist, Terrestrial flora and fauna assessment for Gas pipeline, Liddell Power Station (*prepared for Parsons Brinckerhoff on behalf of Macquarie Generation*)

Zoologist, Species Impact Statement for Dendrobium Area 3 (*BHP Billiton*).

Zoologist, flora and fauna survey of West Cliff power supply (Olsen Environmental Consulting on behalf of BHP Billiton).

Zoologist, flora and fauna assessment of proposed substation at Douglas North (prepared for BHP Billiton)

Zoologist, preliminary flora and fauna assessment of Elderslie Public School (prepared for Department of Commerce, in prep.)

Zoologist, survey and impact assessment of rail maintenance works at Kemira Valley (BHP Billiton).

Zoologist, targeted survey for two threatened bird species within River Red Gum and Box

woodlands for a proposed bridge crossing in western NSW (VicRoads).

Project Manager/Zoologist, monitoring of Long-nosed Bandicoots for a residential development at Manly *(Lend Lease).*

Project Manager/Zoologist, Eight Part Test assessment for proposed residential development in the Blue Mountains *(Hitchins).*

Zoologist, targeted surveys for four threatened flora species and two threatened frog species within hanging swamps. Vegetation mapping and assessment of flora issues along water pipeline between Katoomba and Wentworth Falls in the Blue Mountains *(SCA).*

Zoologist, assessment of potential impacts of subsidence on terrestrial and aquatic ecological values above workings of the Appin and West Cliff Collieries (*BHP Billiton*).

Zoologist, targeted surveys for threatened flora and fauna within a proposed school site (Department of Public Works and Services).

Zoologist, fauna survey including targeted searches for threatened species, populations within nine proposed school sites from Wyong to Shell Harbour *(Department of Public Works and Services.)*

Zoologist, assisted in fauna survey associated with an Environmental Impact Assessment for a proposed highway upgrade from Moorland to Herons Creek *(RTA).*

Project Manager/Zoologist, targeted survey for the Green and Golden Bell Frog for a proposed industrial development at Yennora Wool Distribution Park *(Urbis).*

Zoologist, assessment of potential impacts of subsidence on riparian vegetation and fauna habitats at Cataract Creek and Ousedale Creek above workings of the West Cliff Colliery *(BHP).*

Zoologist, assessment of the impact of a proposed industrial development at Yennora Wool Distribution Park *(Urbis).*

Zoologist, assisted in the assessment of the impact of subsidence on upland swamp communities on the Woronora Plateau *(BHP).*

Technical Assistant, project assessing waterbird requirements of Menindee Lakes *(Department of Land and Water Conservation)*.

Zoologist, fauna assessment component of the Environmental Impact Assessment for the proposed transport extension for Friskies Pet Care, Blayney. *(SEMF).*

Project Manager/Zoologist, fauna and flora component of the Environmental Impact Assessment for the proposed Sawmill Facility at Bombala. *(SEMF).*

Zoologist, bird assessment for the proposed dredging operation for Sydney Airport *(Sydney Airport Authority).*

Zoologist/Technical Assistant, fauna and flora survey associated with a Species Impact Statement for proposed mining operation at Wollongong *(BHP)*

Zoologist, fauna assessment associated with communication upgrade *(2000 for Transgrid).*

Zoologist:,habitat assessment of the Red Crowned Toadlet within an urban golf course. *(Avondale Golf Club).*

Zoologist, fauna assessment associated with buffer assessment for an industrial development at Silverwater *(Trafalgar Corporate).*

Zoologist, Assisted biologist with habitat assessment for threatened species on an urban golf course (*Avondale Golf Club).*

PUBLICATIONS:

Terri has written and contributed to over 60 reports.

SIAN WILKINS — CURRICULUM VITAE

POSITION:
Botanist, Biosis Research Pty. Ltd.

QUALIFICATIONS:
Bachelor of Environmental Science (Hons I) (Terrestrial Biology) University of New South Wales
Statement of Attainment in Bushland Weed Control – Padstow TAFE

CERTIFICATES:
Current Senior First Aid 11475NT
General Induction for Construction work in NSW (Green Card) - WorkCover NSW
Introductory 4WD Training

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:
Ecological Society of Australia
Australian Network for Plant Conservation

EMPLOYMENT PROFILE:

2004-	Botanist, Biosis Research Pty. Ltd.
2002-2004	Botanist, Anne Clements and Associates Pty. Ltd.

FIELDS OF COMPETENCE:
- ✓ flora survey and identification
- ✓ native vegetation classification and mapping
- ✓ rare or threatened species and ecological communities assessment
- ✓ environmental impact statement – natural environment
- ✓ impact minimisation (mitigation) guidelines
- ✓ project management, research, data analysis and report preparation
- ✓ monitoring rehabilitation of vegetation

PROFESSIONAL EXPERIENCE:
Sian has over five years experience in applied conservation biology and consulting. Sian has experience conducting vegetation surveys in a range of different environments across NSW, including identification and assessment of endangered ecological communities and targeted surveys for threatened plant species.

Sian has been involved in a number of major projects during her time with Biosis Research. She has been the main botanist on a number of road projects including the upgrade of the Pacific Highway from Tintenbar to Ewingsdale, the Ballina Bypass and the upgrade of the Princes Highway from Gerringong to Bomaderry. Sian has also been involved in various other major road projects, including the upgrade of the Pacific Highway from Woodburn to Ballina, the upgrade of the Pacific Highway from the F3 to Raymond Terrace and the upgrade of the New England Highway from the F3 to Branxton. Sian has also been involved in a number of projects for major coal mining companies, including long-term ongoing monitoring of the impacts of subsidence due to longwall mining on native vegetation, as well as survey and impact assessments for proposed longwall mining and coal mining exploration activities in the Sydney Catchment Area south of Sydney. Sian has also been involved in a number of smaller projects such as upgrades of local roads, residential subdivisions, upgrades and installations of small substations and powerlines and investigations of proposed school sites.

Sian has extensive experience in report preparation, including flora impact assessments in accordance with the relevant state and commonwealth legislation. Sian also has experience

preparing vegetation management plans and preparing reports for proceedings in the Land and Environment Court.

A sample of key professional experience at Biosis Research is presented below.

Project Manager/Botanist, terrestrial ecology investigations, constraints mapping, targeted surveys and vegetation mapping for the Princes Highway Upgrade from Gerringong to Bomaderry (*for Maunsell and RTA*).

Project Manager/Botanist, flora and fauna assessment of Ballina Bypass modifications *(for Arup and RTA).*

Project Manager/Botanist, flora, fauna and archaeological assessment of proposed Longwall mining in Appin *(for BHP Billiton).*

Project Manager/Botanist, flora and fauna survey of West Cliff power supply (*for Olsen Environmental Consulting and BHP Billiton).*

Project Manager/Botanist, flora and fauna assessment of proposed substation at Douglas North *(for BHP Billiton).*

Project Manager/Botanist, targeted survey for *Eucalyptus macarthurii* and impact assessment for proposed school site at Bowral (*for Department of Commerce*).

Project Manager/Botanist, preliminary flora and fauna assessment of Elderslie Public School (*for Department of Commerce*).

Project Manager/Botanist, survey and impact assessment of rail maintenance works at Kemira Valley (*for BHP Billiton*).

Project Manager/Botanist, impact assessment of proposed tree removal on Cumberland Plain Woodland in Rouse Hill (*for Rouse Hill Infrastructure*).

Project Manager/Botanist, survey and impact assessment for threatened species, populations and communities for flood mitigation works, Wollongong Council Area (*for Forbes Rigby*).

Project Manager/Botanist, survey for threatened species, populations and communities in western Sydney (*for Minter Ellison*).

Project Manager/Botanist, targeted survey for *Melaleuca biconvexa,* the Entrance Road upgrade (*for RTA*).

Project Manager/Botanist, targeted survey for *Acacia chrysotricha* for the Nambucca District Water Supply Scheme Augmentation (*for Department of Commerce*).

Project Manager/Botanist, survey and impact assessment, expansion of Wattle Grove School in south-western Sydney (*for Department of Commerce*).

Project Manager/Botanist, Flora and fauna habitat assessment for proposed upgrade of Bulli Pass (*2007 for NSW RTA*).

Botanist, Flora and fauna impact assessment for a telecommunications facility at King's Point (*2008 for Daly International/Telstra*).

Botanist, Preparation of conservation advice documents for federally listed threatened species (*2008 for the Department of Environment, Water, Heritage and the Arts*).

Botanist, Post mining flora habitat assessment for Dendrobium Longwall 3 End of Panel Report (*2008 for BHP Billiton*).

Botanist, Flora habitat assessment for Appin Area 3 End of Panel Report (*2007 for BHPBilliton*).

Botanist, terrestrial ecology investigations, constraints mapping, targeted surveys and assessment of the upgrade of the Pacific Highway from Tintenbar to Ewingsdale in the North Coast (*for RTA*).

Botanist, ground-truthing of vegetation mapping and targeted surveys for the upgrade of the Pacific Highway from Woodburn to Ballina (*for Hyder Consulting*).

Botanist, flora surveys, vegetation mapping and impact assessment for West Cliff (*for BHP Billiton*).

Botanist, independent ecological review of Species Impact Statement for a proposed commercial development at Byron Bay (*for Department of Planning*).

Botanist, preliminary flora, fauna and archaeological assessment of proposed school site at Bowral (*for Department of Commerce*).

Botanist, long-term monitoring of the potential effects of subsidence due to longwall mining on

rainforest, sclerophyll woodland and upland swamps in the Sydney Catchment Area (*for BHP Billiton*).

Botanist, monitoring of impacts of quarrying on native vegetation, Hartley (for *Austen Quarry*).

Botanist, assessment of the impacts of subsidence from proposed longwalls on terrestrial flora and fauna (*for Centennial Coal*).

Botanist, flora and fauna impact assessment of proposed powerline at Prospect (integral Energy)

Botanist, flora and fauna assessment of proposed new buildings at Caringbah High School (*for Department of Commerce*).

Botanist, survey and reporting for Hoxton Park Airport Opportunities and Constraints Assessment *(for HPAL)*.

Botanist, survey and reporting in Cumberland Plain Woodland at Hoxton Park (Integral Energy).

Botanist, survey and assessment of proposed switching station at East Appin (*for BHP Billiton*).

Botanist, survey and conservation assessment of native vegetation communities of the Meeting Place Precinct, Botany Bay National Park (*for Department of Environment and Conservation*).

Botanist, survey and impact assessment of coal mining exploration activities in the Sydney Catchment Area (*for BHP Billiton*).

Botanist, survey and impact assessment of subsidence due to longwall mining in the Sydney Catchment Area (*for BHP Billiton*).

Botanist, targeted survey and impact assessment of proposed road upgrade and bridge crossing the Hunter River, Maitland (*for RTA*).

Botanist, survey and impact assessment, including preliminary constraints assessment and options assessment, F3 to Raymond Terrace (*for RTA*).

Botanist, survey and impact assessment of proposed school site, Central Coast (for *Department of Commerce*).

Botanist, survey and impact assessment for the upgrade of Cowpasture Road, Hoxton Park (*for RTA*).

Botanist, pre-clearance surveys for threatened species and noxious weeds for the upgrade of Windsor Road (*for Maunsell*).

Botanist, survey and impact assessment for industrial development in Rooty Hill (*for ReadyMix*).

Botanist, survey of six proposed school sites in western Sydney (*for Department of Commerce*).

Botanist, tagging of threatened species in western Sydney for proposed upgrade of electricity easement (*for Integral energy*).

PUBLICATIONS:

Sian has been involved in the publishing of over 40 consultant reports and the following scientific paper.

Wilkins S., Keith D. A., and Adam P. (2003). Measuring success: Evaluating the Restoration of a Grassy Eucalypt Woodland on the Cumberland Plain, Sydney, Australia. *Restoration Ecology* Vol. 11 (4), 489-503.

NATHAN W. SMITH — CURRICULUM VITAE

POSITION:

Botanist, Biosis Research Pty. Ltd.

QUALIFICATIONS:

Bachelor of Science (Resource & Environmental Management), School of Earth Sciences, Macquarie University, Sydney.

Certificate II & IV Bushland Regeneration, School of Horticulture, Northern Sydney Institute of Technology and Further Education, Ryde.

Statement of Attainment in Spatial Information Systems, School of Surveying, Sydney Institute of Technology, Ultimo.

EMPLOYMENT PROFILE:

2003-2005	Botanist, Biosis Research Pty. Ltd.
2001-2003	Toolijooa Environmental Restoration Pty Ltd, Native Plant Seed Collector and Bush Regeneration Projects Manager.
2000-2003	North Sydney Council, Bushcare Supervisor.
1998-2003	Australian Bushland Restoration Pty Ltd, Bushland Project Manager**.**
1996-1997	Agserv Pty Ltd, Weed Control Operator & Bush Regeneration Supervisor.

FIELDS OF COMPETENCE:

- ✓ weed management & bushland site assessment
- ✓ weed and native plant identification
- ✓ native vegetation classification
- ✓ habitat restoration
- ✓ threatened plant assessment

PROFESSIONAL EXPERIENCE:

Biosis

Weed Management Plan for F3 to Branxton Link (RTA)

Vegetation Management Plan for Tullimbah Village, Shellharbour LGA (Clousten Associates)

Corrimal Colliery – No. 2 Ventilation Shaft Site, Weed Management and Revegetation Works (BHP Billiton Illawarra Coal)

Port Kembla No. 2 Colliery – Adits, Weed Management and Revegetation Works (BHP Billiton Illawarra Coal)

Elouera Colliery - Nebo Shaft Sites 1, 2 & 3 Weed Management and Revegetation Works (BHP Billiton Illawarra Coal)

Other

Toolijooa Environmental Restoration Pty Ltd – Project Manager, *Grevillea caleyi* Bush Regeneration Project (Warringah Council). *G. caleyi* is listed as Endangered under the NSW *Threatened Species Conservation Act* 1995.

Australian Bushland Restoration Pty Ltd – Vegetation Management Plan for Collins Beach, Sydney Harbour National Park. The plan had to account for potential impacts of weed management strategies on the endangered populations of Long-nosed Bandicoot and Little Penguins that inhabit the area.

THERESA PIZZUTO — CURRICULUM VITAE

POSITION:

Research Assistant, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Royal Zoological Society of New South Wales.

QUALIFICATIONS:

Master of Applied Science (Wildlife Health and Population Management), The University of Sydney NSW

Bachelor of Science (Biology), The University of Sydney, NSW

Certificate III in Animal Studies (Veterinary Nursing), TAFE NSW, Richmond

Four Wheel Drive Off-road Driver Training and Hazard Awareness. National Driver Education, 2005

Basic Four Wheel Drive course, Level 1, Off Road Driver Training, 2005.

EMPLOYMENT PROFILE:

2007-	Research Assistant, Biosis Research Pty. Ltd.
2005-2006	Kangaroo Management Officer, Cumberland Ecology
2006	Volunteer Field Assistant, African Wild Dog Conservation Zambia, Zambia
2005-2006	Volunteer, Veterinary and Quarantine Centre (VQC), Taronga Park Zoo, Sydney, Zoological Parks Board of New South Wales .

FIELDS OF COMPETENCE:

- ✓ fauna survey and identification (mammals, birds, amphibians, reptiles)
- ✓ mammalian fauna research, including rare and threatened species research and monitoring
- ✓ radio-tracking
- ✓ habitat assessment and assessment of faunal habitat use
- ✓ experimental design, research and report production
- ✓ feral pest control and monitoring

PROFESSIONAL EXPERIENCE:

A sample of key professional experience is presented below.

Kangaroo Management Officer, Assisting in the implementation of the Macrofauna Management Plan for the management of an enclosed wild population of Eastern grey (*Macropus giganteus*) and Red (*Macropus rufus*) kangaroos within Western Sydney, NSW. Cumberland Ecology (*for Delfin Lend Lease, 2005/06*)

Assistant Consultant, Targeted surveys for threatened species of owls and mammals at Awaba, NSW. Cumberland Ecology.

Volunteer Field Assistant, Assisting with radio-tracking of African wild dogs (*Lycaon pictus*) and density estimate surveys of prey and predator species, Zambia.

Chief Investigator, Masters Research Project, Spool and line tracking to investigate microhabitat

use by the Brush-tailed bettong (*Bettongia penicillata*) and Burrowing bettong (*B. lesueur*) in semi-arid New South Wales, Scotia Sanctuary, Australian Wildlife Conservancy.

Volunteer Field Assistant, Assisted with study on population dynamics and diet of bettongs, (*Bettongia lesueur, B. penicillata*), greater bilbies (*Macrotis lagotis*), and bridled nailtail wallabies (*Onychogalea fraenata*); and with population dynamics of numbats (*Myrmecobius fasciatus*), Scotia Sanctuary, NSW. The University of Sydney.

Volunteer Field Assistant, Cane toad (*Bufo marinus*) and native frog breeding site and habitat assessment in Northern NSW. The University of Sydney.

Volunteer, Birds Australia, North Head bird surveys, Sydney NSW.

Volunteer Keeper, Veterinary nursing assistance and **c**aptive husbandry of native and exotic fauna, including food preparation and feeding, cleaning, handling, housing, environment enrichment, record keeping, observing behaviour. - macropods, possums, birds, snakes, lizards, turtles, echidnas, quolls, various exotic species. Taronga Park Zoo, Veterinary and Quarantine Centre.

PUBLICATIONS:

Pizzuto, T.A., Finlayson, G.R., Crowther, M.S. and Dickman, C.R. (2007) Microhabitat use by the brush-tailed bettong (*Bettongia penicillata*) and burrowing bettong (*B. lesueur*) in semiarid New South Wales: Implications for Reintroduction Programs. *Wildlife Research*, Volume 34(4), pp 271-279.

MELISSA J STARLING — CURRICULUM VITAE

POSITION:

Research Assistant, Biosis Research Pty. Ltd.

QUALIFICATIONS:

BSc (Honours) Australian National University
Senior First Aid (Remote) Certificate – Parasol EMT, expires 30/7/2007
Occupational Health and Safety for Construction Sites Green Card.

EMPLOYMENT PROFILE:

2007	Research Assistant, Biosis Research Pty. Ltd.
2007	Consultant, Landscope, NSW.
2007	Ecological Consultant, LesryK Environmental Consulting, NSW.
2006	Research Assistant, Centre for Tropical Research, Los Angeles.
2005-2006	Research Assistant, bird behavioural ecology research group, ANU, ACT.
2004	Research Assistant, vertebrate physiology lab, ANU, ACT.
2004	Research Assistant, ANU Green, ACT.
2003-2004	Volunteer Field Assistant, Pheasant Coucal Project, ANU, NT.

FIELDS OF COMPETENCE:

- ✓ Terrestrial ecology
- ✓ Zoology
- ✓ Flora and fauna survey and identification
- ✓ Identification of Australian vertebrates
- ✓ Literature reviews
- ✓ Experimental design
- ✓ Laboratory experimental techniques

PROFESSIONAL EXPERIENCE:

A sample of key professional experience is presented below.

Ecologist, Prepared Review of Environmental Factors for installation of a Variable Message Sign. *(2007, Gosford City Council)*

Zoologist, Managed fauna section of flora and fauna survey. *(2007, Wyong Shire Council)*

Zoologist, Prepared desktop fauna survey. *(2007, Hunter Water Corporation).*

Zoologist, Assisted in preparing targeted Green and Golden Bell Frog report. *(2007, LesryK Environmental Consulting)*

Research Assistant, Assisting with preparation of PCR plates, data entry and data analysis, and general laboratory maintenance. *(2006 Centre for Tropical Research, UCLA, LA)*

Field Assistant, Searching for nests, assisting with mist-netting, banding and measuring adult birds. *(2006 for PhD project for Centre of Tropical Research, UCLA, in Mexico)*

Research Assistant, Management of Superb Fairy-wren territories, assisting in mist-netting, banding and bleeding of nestlings, data collection and entry. *(2005/2006 for bird behaviour research group, School of Botany and Zoology, ANU, ACT)*

Chief Investigator, Co evolution between Pallid Cuckoo and its host species. *(2004/2005 Honours project, ANU, ACT)*

Research Assistant, Management & responsibility for laboratory beetle adults and larvae during experimental trials, data collection and collation, mixing chemical standards, operating NIR machine. *(2004 for vertebrate physiology lab, School of Botany and*

Zoology, ANU, ACT)

Research Assistant, Identifying terrestrial invertebrate samples to Order or Family. *(2004 for ANU Green, ACT)*

Field Assistant, Finding nests and collection of behavioural observations of Pheasant Coucal in Darwin, NT for a PhD project on natural history and breeding system of the Pheasant Coucal. *(2003/2004 for research project for PhD candidate at ANU)*

PUBLICATIONS:

Starling, M., Heinsohn, R. Cockburn, A., Langmore, N.E. *(2006)* Cryptic gentes revealed in the Pallid Cuckoo *(Cuculus pallidus)* using reflectance spectrophotometry. *Proceedings of the Royal Society of London, Series B.* **273**.

KATIE CARTNER — CURRICULUM VITAE

POSITION:

Zoologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Waikato Botanical Society, New Zealand.

QUALIFICATIONS:

Bachelor of Science (Biological Sciences) University of Waikato, New Zealand.
Other:
Senior First Aid Certificate – St John Ambulance, June 2004.
Cardiopulmonary Resuscitation – St John Ambulance, June 2006.
OHS General Induction for Construction Work in NSW (Green Card) – June 2006.
OHS Workplace Consultation – National Safety Council of Australia, January 2006.

EMPLOYMENT PROFILE:

2006-	Zoologist, Biosis Research Pty. Ltd.
2005-2006	Research Assistant, Biosis Research Pty. Ltd.
2004-2005	Technical Assistant, Biosis Research Pty. Ltd.
2003-2004	Administration Assistant, Omnilab Pty Ltd.
2003	Volunteer, Department of Conservation (Mercury Islands, NZ).
2003	Volunteer, Department of Conservation (Tiri tiri Matangi Island, NZ)
2001-2003	Field and Laboratory Technician, Landcare Research, NZ.
2000-2001	Laboratory Technician, AgResearch, NZ.

PROFESSIONAL EXPERIENCE:

Katie has over four years experience working in an assistant role in various natural heritage assessments, surveys and research. A sample of key experience is listed below.

Zoologist, Targeted surveys for threatened owl species and threatened snake Broad-headed Snake *Hoplocephalus bungaroides* for the proposed Westcliff coal wash emplacement, Area 3 (*2006 for BHP Billiton*)

Zoologist, Targeted surveys for microchiropteran bats at Elouera Colliery Portals, specifically for Eastern Bent-wing Bat *Miniopterus schreibersii*, to assess bat presence and usage of portals (*2006 for BHP Billiton*).

Zoologist, Targeted surveys for threatened frog species Littlejohn's Tree Frog *Litoria littlejohni* in Dendrobium Area 2 (*2006 for BHP Billiton*).

Zoologist, Terrestrial fauna habitat assessment of Tower 62 Access Track in Lane Cove National Park (*2006 for EnergyAustralia*).

Zoologist, Ecological Assessment of Transmission Line Corridors at Tallawarra Gas Power Station (2006 for URS Pty. Ltd.).

Zoologist, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 2, seasonal surveys (*2005 and 2006 for BHP Billiton*).

Research Assistant, Macrophyte monitoring surveys at Penrith Lakes (*2006 for Penrith Lakes Development Corporation*).

Zoologist, Terrestrial fauna habitat assessment of Bulli Mine Rehabilitation Sites *(2005 for Forbes Rigby Pty. Ltd.)*.

Field Assistant, Assisted with an assessment of possible impacts of subsidence on creek systems *(2005 for BHP Billiton)*.

Field Assistant, Conducted aquatic ecology assessment of the Bundanoon Sewerage Treatment Plant upgrades *(2005 for SMEC Australia)*.

Zoologist, Fauna habitat assessment of track leading to ventilation shaft site *(2005 for BHP*

Billiton).

Field Assistant, Terrestrial fauna habitat assessment and targeted survey for *Litoria aurea* at the proposed P5 Mountain Cross Course *(2005 for Pittendrigh Shinkfield & Bruce)*.

Field Assistant, Targeted survey for *Melaleuca biconvexa*, the Entrance Road upgrade *(2005 for RTA Central Coast)*.

Field Assistant, Aquatic habitat assessment for the upgrade of Cowpasture Road *(2005 for RTA)*.

Field Assistant, Aquatic habitat assessment for Windsor Rd pre clearance surveys *(2005 for Maunsell Australia)*.

Field Assistant, Re-vegetation of Goaf Ejection Stack Site Rehabilitation Project (2005 for BHP Billiton).

Field Assistant, Sub-surface testing for proposed wind farm, Crookwell II *(2005 for Gamsea Energy Australia)*.

Field Assistant/Zoologist, Assisted in terrestrial fauna monitoring to assess potential impacts of subsidence in Dendrobium Area 1 *(2004 and 2005 for BHP Billiton).*

Field Assistant, Set-up Study Sites and assisted with botanical surveys for monitoring the effects of subsidence *(2004 for BHP Billiton)*.

Field Assistant/Zoologist, Assisted in terrestrial fauna surveys including targeted surveys for threatened species for F3 – Raymond Terrace Pacific Highway Upgrade *(2004 for Maunsell Australia)*.

Field Assistant/Botanist, Conducted targeted surveys of *Melaleuca biconvexa* for Oxley Highway Bypass SIS *(2004 for RTA Technical Services)*.

Research Assistant, Conducted background research of subsidence impacts literature *(2004 for BHP Billiton)*.

Field Assistant/Zoologist, Conducted terrestrial fauna monitoring to assess the potential impacts of subsidence in Elouera Swamps *(2004 for BHP Billiton)*.

Field Assistant, Translocation and radio-tracking surveys of the Middle Island Tusked Weta *Motuweta isolata (2003 for Department of Conservation, NZ)*.

Field Assistant, Animal handling and welfare on Tiri Tiri Matangi Island Scientific Reserve *(2003 for Department of Conservation, NZ)*.

Database Co-ordinator, Managed Access databases of target bird species *(2003 for Landcare Research, NZ)*.

Field Technician, Conducted field surveys to map the abundance and distribution of native bird species *(2003 for Landcare Research, NZ)*.

Field Technician, Assisted a Plant Ecologist/Botanist with PhD research studies on the reproductive strategies of native shrub species (*2001 for Landcare Research, NZ)*.

Laboratory Technician, Conducted clover-nematode interaction field trials and clover root-weavil experiments *(2000 and 2001 for AgResearch, NZ)*.

Field Assistant, Radio-tracking of Brown Kiwi *Apteryx australis mantelli* and kiwi predator control (*1998 for Department of Conservation and Landcare Research, NZ*).

CONSULTANT REPORTS:

Harrington, R., Smith, N., Charlton, J., Muir, G. and **Cartner, K.** 2006. Proposed F3 Freeway to Branxton Link - Updated Additional Flora and Fauna Assessment: Threatened Species Assessment for Proposed Design Changes (prepared for NSW Roads and Traffic Authority).

Cartner, K. and Smith B. 2006. Flora and Fauna Assessment: Tower 62 Access Trail, Lane Cove National Park (prepared for EnergyAustralia).

Cartner, K. and Smith, B. 2006. Tallawarra Power Station, Transmission Line Installation. (prepared for URS Pty. Ltd. on behalf of TRUenergy).

Beitzel, M., Taylor Wood, E., Suansri, R. & **Cartner, K.** 2006. Macrophyte Survey of Penrith Lakes. Report for Penrith Lakes Development Corporation.

Clarke, R., Harrington, R., Smith, N. & **Cartner, K.** 2006. Southern Exploration Drilling Area (Boyd Bay and Norman Creek) Flora and Fauna Baseline Survey. Report for Comalco Weipa.

Smith, N., Harrington, R., Clarke, R. & **Cartner, K.** 2006. Northern Exploration Drilling Area (Musgrave) Flora and Fauna Baseline Survey. Report for Comalco Weipa.

Harrington, R., Smith, N., Clarke, R., Beitzel, M. & **Cartner, K.** 2005. Northern Exploration Drilling Area (Palm Creek) Flora and Fauna Baseline Survey. Report for Comalco Weipa.

MATTHEW BEITZEL — CURRICULUM VITAE

POSITION:
Aquatic Ecologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:
Australian Society of Fish Biology

QUALIFICATIONS:
Bachelor of Science (Ecology) Australian National University

Bachelor of Applied Science (Hons) University of Canberra
Genetic population structure of freshwater fish

EMPLOYMENT PROFILE:

2004-	Aquatic Ecologist, Biosis Research Pty. Ltd.
2004	Bushcare Coordinator, Lane Cove Council
2003-04	Professional Officer 1 Environment ACT, Wildlife Research & Monitoring,
2001-03	Ranger, Environment ACT, Parks & Conservation Service
2001	Research/field assistant Environment ACT, Wildlife Research and Monitoring

FIELDS OF COMPETENCE:
- ✓ Aquatic fish survey and identification
- ✓ Aquatic habitat assessment
- ✓ Water quality assessment
- ✓ Field and laboratory experimental techniques
- ✓ Threatened species assessment
- ✓ Fauna handling

PROFESSIONAL EXPERIENCE:
Matthew has over 5 years experience in conservation biology and land management including monitoring and research of freshwater environments in the ACT NSW and VIC.

PROJECTS:

Aquatic Ecologist: Review and evaluation of online and offline dam options for the proposed urbanisation of the lower Molonglo Valley ACT (ACTPLA)

Aquatic Ecologist: Annual macrophyte monitoring of Penrith lakes (PLDC)

Aquatic Ecologist: Fish Habitat and stoking plan for Penrith Lakes (PLDC)

Aquatic Ecologist: Woodburn to Ballina Pacific Hwy Upgrade; including assessment for Oxleyan Pygmy Perch (Hyder on behalf of the RTA)

Aquatic Ecologist: Terrestrial and Aquatic Flora and Fauna Assessment of the upgrade to Blaxland Common, Parramatta River (Sydney Olympic Park Authority)

Project Manager /Aquatic Ecologist: Aquatic ecology investigations into Groundwater Dependant

Ecosystems in the Upper Nepean (for SMEC on behalf of the SCA)

Aquatic Ecologist: Terrestrial and Aquatic Flora and Fauna Assessment of the Proposed Power line Clyde River, Batemans Bay (Energy Australia)

Project Manager/Aquatic Ecologist: Aquatic Ecology Assessment of Angus Creek Rooty Hill (for NECS on behalf of Readymix)

Aquatic Ecologist: Flora Fauna and Aquatic Ecology Assessment of the Proposed Penrith Lakes Pipeline (Maunsell on behalf of PLDC)

Aquatic Ecologist: Aquatic fauna assessment of Dodds Creek, Flinders, Victoria in the vicinity of a proposed sewer alignment crossing. (2005 for *MWH Australia*).

Technical Specialist /Aquatic Ecologist: EPBC Referral translocation of *Galaxias pusilla*. (Szaintop Constructions)

Aquatic Ecologist: Aquatic Ecology Assessment of the F3 to Branxton National Highway Upgrade (RTA).

Technical Specialist: Targeted Survey for Heath Frog *Litoria littlejohni* (BHPB)

Ecologist/Aquatic Ecologist: Windsor Road Upgrade (The Alliance/Maunsell/RTA) Clearing of hollow trees and aquatic ecology and fauna site assessment.

Aquatic Ecologist: Preliminary assessment of the third crossing of the Hunter River Maitland (RTA)

Project Manager/Aquatic Ecologist: Update of Flora and Fauna Assessment of the Upgrade to Cowpasture Road, Hoxton Park (RTA)

Aquatic Ecologist: Assessment of Bowra Creek and the Nambucca Water supply (for NSW Department of Commerce and Nambucca Council)

Technical Specialist: Flora & Fauna Assessment for Goulburn Drought Emergency Water Supply Works. (for NSW Department of Commerce)

Aquatic Ecologist Aquatic Ecology Assessment of the Bundanoon Sewerage Treatment Plant Upgrades and Reuse (SMEC/ Department of Commerce/ Wingecarribee Shire Council)

Professional officer (Environment ACT): Reintroduction of Trout Cod, including radio tracking, fish care and response to environmental flows.

Professional officer (Environment ACT): Annual fish survey of the ACT region including urban and water supply lakes, rivers and STP discharges.

Professional officer (Environment ACT): Underwater video analysis of fish diel activity.

Professional officer and Parks Ranger (Environment ACT): Bushfire impact and recovery on native ecosystems surveys

Parks Ranger (Environment ACT): Urban wildlife including swooping bird management.

RACHEL V. BLAKEY — CURRICULUM VITAE

POSITION:
Zoologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:
Birds Australia
Australasian Wader Study Group

QUALIFICATIONS:
BSc (Honours) University of Queensland, St Lucia, QLD.
BSc (Dean's scholarship) Zoology, Monash University, Clayton, VIC.
Other:
HSTRA100 Basic Height Safety and Tree Access,Total Height Safety, 24/11/06
NSW General Boat license #01129768, expires 31/10/09.
PADI Divemaster qualification (includes PADI Rescue Diver and Dive Medic training).
Senior First Aid Certificate – St John Ambulance, expires 14/12/2008.

EMPLOYMENT PROFILE:

2007-present	Zoologist, Biosis Research Pty. Ltd.
2006-2007	Research Assistant, Biosis Research Pty. Ltd.
2005-2006	Technical Assistant, Biosis Research Pty. Ltd.
2004-2005	Executive Assistant, Giaconda Limited
2005	Volunteer Research Assistant, Marine and Estuarine Ecology Unit, University of Queensland
2003-2004	Science Tutor, Moreton Bay Research Centre, Stradbroke Island, QLD
2002-2004	Divemaster Village Dive, Exmouth, WA & Dive Victoria, Portsea, Vic & Bluezone Scuba, Brisbane, QLD.

FIELDS OF COMPETENCE:
- ✓ Shorebird/Waterbird surveys
- ✓ Bat surveys
- ✓ Terrestrial bird surveys
- ✓ Frog surveys
- ✓ Field and laboratory experimental techniques
- ✓ Best practice tree-trapping including rope access & egress

PROFESSIONAL EXPERIENCE:
A sample of key professional experience is presented below.

Zoologist, Targeted surveys for threatened frog, diurnal bird, nocturnal bird and reptile species for Dendrobium Area 3 Species Impact Statement (*2007 for BHP Billiton*).

Research assistant, Macrophyte mapping surveys at Penrith Lakes (*2007 for Penrith Lakes Development Corporation Ltd.*)

Research assistant, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 2, seasonal surveys (*2007 for BHP Billiton*).

Research assistant, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 1, seasonal surveys (*2007 for BHP Billiton*).

Research assistant, Targeted surveys for threatened *Eucalyptus parramattensis* subsp. *decadens* in the Hunter Valley (*2007 for RTA*).

Field participant, Independent shorebird/seabird population observation within Botany Bay including Taren Point (Endangered Ecological Community) & Towra Point Nature reserve (Ramsar site) (Personal, 2006/2007)

Research assistant, Targeted surveys for threatened species of birds, mammals, frogs and reptiles at West Cliff's Coalwash Emplacement Area 3 (*2006 for BHP Billiton*).

Research assistant, Terrestrial flora monitoring to assess the potential impacts of subsidence in Dendrobium Area 2, seasonal surveys (*2006 for BHP Billiton*).

Research assistant, Terrestrial flora monitoring to assess the potential impacts of subsidence in Dendrobium Area 1, seasonal surveys (*2006 for BHP Billiton*).

Research Assistant, Winter targeted bat surveys of Elouera Colliery portals, specifically for Eastern Bent-wing Bat *Miniopterus schreibersii*, to assess bat presence and usage of portals (*2006 for BHP Billiton*).

Research assistant, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 2, seasonal surveys (*2006 for BHP Billiton*).

Research assistant, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 1, seasonal surveys (*2006 for BHP Billiton*).

Research assistant, Targeted surveys for threatened Littlejohn's Tree Frog in Illawarra catchment area, *Litoria littlejohni* including habitat assessments (2006 for *BHP Billiton*).

Research assistant, Flora monitoring to assess the potential impacts of subsidence in Dendrobium Area 1, seasonal surveys (*2006 for BHP Billiton*).

Research assistant, Targeted surveys for threatened Cumberland Plain Land Snail, *Meridolum corneovirens* at Prospect Reservoir (*2006 for Integral Energy*).

Field assistant, Targeted surveys for threatened frog species at Sydney Olympic Park, including the Green and Golden Bell Frog, *Litoria aurea (2006 for Sydney Olympic Park Authority).*

Field assistant, Aquatic surveys for proposed Penrith Lakes Pipeline, Penrith Lakes (*2006 for Maunsell Aecom Australia Pty. Ltd.*).

Field Assistant, Autum targeted bat surveys of Elouera Colliery portals, specifically for Eastern Bent-wing Bat *Miniopterus schreibersii*, to assess bat presence and usage of portals (*2006 for BHP Billiton*).

Field Assistant, Terrestrial fauna surveys including targeted searches for threatened species for F3 to Raymond Terrace Pacific Highway Upgrade, Summer Survey (*2006 for Maunsell Australia*).

Field assistant, Terrestrial fauna habitat assessment of Appin Area 3 Seismic lines and Boreholes (*2006 for BHP Billiton*).

Field assistant, Vegetation surveys as part of Honours project examining effects of disturbance on

vegetation communities in Castlereagh woodlands *(2005 for University of Technology Sydney).*

Project Manager, Population counts of resident shorebird species on intertidal mudflats of Stradbroke Island, Moreton Bay (Ramsar wetland) (*2003/2004 for University of Queensland*)

Project Manager, Diet analysis and field observation of the Eastern Curlew (*Numenius madagascariensis*) on intertidal mudflats of Stradbroke Island, Moreton Bay (Ramsar wetland) (*2003/2004 for University of Queensland*)

Field participant, Shorebird populations counts with Queensland Wader Study Group within Moreton Bay wetlands area (Ramsar wetland) (2003/2004, QWSG).

Research Assistant, Aquatic field surveys and estuarine fish, crustacean and macro-invertebrate identification to species level, as part of Habitat mosaics study in Moreton Bay (Ramsar wetland) (*2004 for Marine and Estuarine Ecology Unit*).

Field Supervisor, Supervising and Conducting water quality monitoring and macro-invertebrate surveys of freshwater lakes and swamps at Stradbroke Island, QLD, as part of the *Waterwatch Queensland* program (*2004 for Moreton Bay Research Centre*).

Divemaster, Management & responsibility for recreational Dive vessel of 10 people including: Boat and diving safety briefing, in-water supervision, inspection of new sites and marine life interpretation (*2003/2004 for Bluezone Scuba, Brisbane, QLD*).

Research Diving Assistant, Collection and tagging of Short-tailed nudibranch *Ceratosoma brevicaudatum* for Honours project examining nudibranch population dynamics (*2003 for University of Queensland*).

Divemaster, Management & responsibility for recreational Dive vessel of 20 people including: Boat and diving safety briefing, in-water supervision, inspection of new sites and marine life interpretation (*2002/2003 for Dive Victoria, Portsea, Vic*).

Divemaster, Management & responsibility for recreational Dive vessel of 20 people including: Boat and diving safety briefing, in-water supervision, inspection of new sites and marine life interpretation (*2002 for Village Dive, Exmouth, WA*).

Research Assistant, Collection and behavioural monitoring of freshwater leeches *Helobdella papillornata* for research project examining parental care in invertebrates (*2001 for School of Biological Sciences, Monash University*).

PUBLICATIONS:

Blakey, R., Zharikov, Y and Skilleter, G.A. (2006) Lack of an osmotic constraint on intake rate of the eastern curlew *Numenius madagascariensis. Journal of Avian Biology* **37**(4)**:** 299-305.

CONSULTANT REPORTS:

Smith B., Charlton J., Muir G., Smith N., **Blakey R.**, Wilkins S. and Harrington R. 2006. F3 to Branxton Link Electricity Adjustments Species Impact Statement (for NSW RTA and Energy Australia).

Appendix 2
Conservation Rating According to Briggs and Leigh (1996)

Conservation Rating According to Briggs and Leigh (1996)

Briggs and Leigh (1996) list over 5,031 species, subspecies and varieties of plants (5% of native vascular flora of Australia) that have been ranked according to their conservation status. While many of these species are contained within the schedules of various state and federal threatened species legislation (eg. TSC Act and *EPBC* Act), and are subject to legislative provisions under those acts, a great many more do not and as a such are extraneous to statutory assessment processes.

The modified list below presents the range of codes that are, in various combinations, applied to each listed plant species.

1 Species only known from one collection
2 Species with a geographic range of less than 100km in Australia
3 Species with a geographic range of more than 100km in Australia
X Species presumed extinct; no new collections for at least 50 years
E Endangered species at risk of disappearing from the wild state if present land use and other causal factors continue to operate
V Vulnerable species at risk of long-term disappearance through continued depletion.
R Rare, but not currently considered to be endangered.
K Poorly known species that are suspected to be threatened.
C Known to be represented within a conserved area.
a At least 1,000 plants are known to occur within a conservation reserve(s).
i Less than 1,000 plants are known to occur within a conservation reserve(s).
- The reserved population size is unknown.
t The total known population is reserved.
+ The species has a natural occurrence overseas.

Appendix 3
Plant Species Recorded during the Current Surveys

This appendix details plant species recorded in the study area during the November 2006 survey.

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Acacia elata	Mountain Cedar Wattle											+					
Acacia maidenii	Maiden's Wattle														+		
Acmena smithii	Lilly Pilly							+									
Actephila lindleyi					+	+			+								
Adiantum formosum	Giant Maidenhair															+	
Adiantum hispidulum var. *hispidulum*	Rough Maidenhair			+	+	+			+							+	
Ageratina adenophora	Crofton Weed	*		+		+									+	+	
Ageratina riparia	Mistflower	*		+	+	+	+	+							+	+	
Ageratum houstonianum		*		+											+		
Alocasia brisbanensis	Cunjevoi			+					+								
Alphitonia petriei	White Ash								+				+				
Ambrosia tenuifolia	Lacy Ragweed	*						+							+		
Andropogon virginicus	Whisky Grass	*			+	+											
Aphananthe philippinensis	Rough-leaved Elm			+												+	
Araucaria cunninghamii	Hoop Pine			+											+		
Araucaria heterophylla	Norfolk Island Pine	*												+			
Araujia hortorum		*													+		
Archidendron muellerianum			r		+			+									
Archontophoenix cunninghamiana	Bangalow Palm			+				+	+				+	+		+	
Arytera distylis	Twin-leaved Coogera				+	+											
Asplenium australasicum				+	+	+			+		+				+	+	
Austromyrtus dulcis	Midgen Berry					+											
Austrosteenisia glabristyla	Giant Blood Vine			+	+	+			+								
Axonopus affinis	Narrow-leaved Carpet Grass	*		+				+							+		
Baccharis halimifolia	Groundsel Bush	*			+												
Bidens pilosa	Cobbler's Pegs	*		+	+	+		+	+						+		+
Blechnum indicum	Swamp Water Fern			+													
Brachychiton acerifolius	Illawarra Flame Tree			+													

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Briza spp.		*		+													
Bromus catharticus	Prairie Grass	*							+								
Caesalpinia scortechinii	Large Prickle-vine			+													
Calamus muelleri	Lawyer Vine															+	
Caldcluvia paniculosa	Soft Corkwood					+		+									
Callistemon citrinus	Crimson Bottlebrush										+						
Callistemon salignus	Willow Bottlebrush													+			
Calochlaena dubia	Common Ground Fern					+											
Carex longebrachiata	Bergalia Tussock				+	+											
Carronia multisepalea						+			+								
Cassinia uncata	Sticky Cassinia										+						
Centella asiatica	Pennywort			+													+
Ceratopetalum apetalum	Coachwood										+				+		
Christella dentata	Binung			+	+	+										+	
Cinnamomum camphora	Camphor Laurel	*		+	+	+	+	+	+	+	+	+		+	+	+	+
Cirsium vulgare	Spear Thistle	*		+	+			+	+						+		
Cissus antarctica	Water Vine			+	+	+											
Cissus hypoglauca	Giant Water Vine					+											
Clerodendrum floribundum								+	+								
Comesperma spp.				+													
Commelina cyanea	Native Wandering Jew			+					+						+	+	+
Commersonia bartramia	Brown Kurrajong			+				+	+						+		
Conyza albida	Tall Fleabane	*		+		+		+	+								
Coprosma quadrifida	Prickly Currant Bush					+											
Cordyline rubra						+			+								
Cordyline stricta	Narrow-leaved Palm Lily							+									
Crassocephalum crepidioides	Thickhead	*				+			+								
Cryptocarya glaucescens	Jackwood								+								
Cryptocarya laevigata	Red-fruited Laurel															+	
Cryptocarya obovata	Pepperberry			+					+								

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Cupaniopsis anacardioides	Tuckeroo							+			+						
Cyathea australis	Rough Treefern			+	+												
Cynodon dactylon	Common Couch					+									+		+
Dianella caerulea var. *caerulea*	Paroo Lily				+				+								
Dianella caerulea var. *producta*	Blue Flax-lily					+											
Dichelachne micrantha	Shorthair Plumegrass					+											
Dioscorea transversa	Native Yam					+											
Diploglottis australis	Native Tamarind					+		+	+				+		+	+	
Diploglottis campbellii			e										+				
Echinopogon ovatus	Forest Hedgehog Grass			+													
Elaeocarpus grandis	Blue Quandong							+					+				
Elattostachys nervosa	Green Tamarind								+								
Eleocharis sphacelata	Tall Spike Rush			+													
Embelia australiana						+											
Entolasia marginata	Bordered Panic					+											
Eucalyptus microcorys	Tallowwood										+						
Eucalyptus pilularis	Blackbutt										+						
Eucalyptus resinifera ssp. *resinifera*	Red Mahogany										+						
Eucalyptus saligna	Sydney Blue Gum										+						
Eucalyptus spp.												+					
Eupomatia bennettii	Small Bolwarra				+												
Eupomatia laurina	Bolwarra								+								
Ficus coronata	Creek Sandpaper Fig			+	+	+									+	+	
Ficus fraseri	Sandpaper Fig								+								
Ficus macrophylla ssp. *macrophylla*	Moreton Bay Fig			+										+			
Ficus watkinsiana	Strangling Fig			+													
Flagellaria indica	Whip Vine			+													
Flindersia australis	Crow's Ash								+								
Flindersia bennettiana	Bennett's Ash							+									
Foeniculum vulgare	Fennel	*		+													

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Gamochaeta americana	Cudweed	*		+													
Geitonoplesium cymosum	Scrambling Lily					+											
Geranium homeanum	Northern Cranesbill			+													
Gleichenia dicarpa	Pouched Coral-fern					+											
Glochidion ferdinandi var. *ferdinandi*	Cheese Tree			+	+			+	+								
Glyceria australis	Australian Sweetgrass					+											
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	*		+											+		+
Grevillea robusta	Silky Oak							+					+	+			
Guilfoylia monostylis									+								
Guioa semiglauca	Guioa			+	+	+	+	+	+		+		+		+	+	
Harpullia pendula	Tulipwood								+								
Heritiera trifoliolata	White Booyong								+								
Hibbertia scandens	Climbing Guinea Flower			+		+											
Hydrocotyle peduncularis	Pennywort														+		
Hypochaeris radicata	Catsear	*				+		+									
Hypolepis muelleri	Harsh Ground Fern				+	+		+	+								
Impatiens wallerana		*							+								
Imperata cylindrica var. *major*	Blady Grass				+												
Ipomoea cairica		*														+	+
Jacaranda mimosifolia	Jacaranda	*						+						+			
Jagera pseudorhus var. *pseudorhus*				+				+							+	+	
Jasminum dallachii				+	+										+		
Juncus usitatus	Billabong Rush			+													
Lantana camara	Lantana	*		+	+	+	+	+		+		+			+	+	+
Lastreopsis decomposita	Trim Shield Fern					+		+	+								
Ligustrum lucidum	Large-leaved Privet	*				+		+				+					
Ligustrum sinense	Small-leaved Privet	*		+	+	+		+		+		+					
Lomandra longifolia	Spiny-headed Mat-rush							+	+								
Ludwigia spp.				+													
Macadamia tetraphylla	Rough-leaved Queensland Nut		v												+		

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Maclura cochinchinensis	Cockspur Thorn			+	+				+						+	+	
Mallotus philippensis	Red Kamala			+	+	+		+	+		+				+	+	
Marsdenia rostrata	Common Milk Vine									+					+		
Meiogyne stenopetala ssp. *stenopetala*					+												
Melastoma affine						+		+	+								
Melicope elleryana	Pink-flowered Doughwood							+									
Microlaena stipoides var. *stipoides*	Weeping Grass			+	+			+	+								
Mischocarpus pyriformis ssp. *pyriformis*	Yellow Pear-fruit			+													
Moraea spp.															+		
Neolitsea dealbata	White Bolly Gum			+		+	+								+	+	
Nymphaea mexicana	Yellow Water-lily	*		+													
Ochna serrulata	Mickey Mouse Plant	*			+			+									
Omalanthus populifolius						+									+		
Oplismenus aemulus	Basket Grass			+		+		+	+						+		
Pandorea pandorana ssp. *pandorana*	Wonga Vine															+	
Paspalum dilatatum	Paspalum	*		+		+		+									+
Paspalum wettsteinii	Broad-leaved Paspalum			+	+			+							+		
Passiflora edulis	Common Passionfruit	*			+			+									
Passiflora herbertiana ssp. *herbertiana*	Native Passionfruit					+		+									
Pennisetum clandestinum	Kikuyu Grass	*		+				+									+
Persicaria hydropiper	Water Pepper			+													
Persicaria lapathifolia	Pale Knotweed			+													
Phytolacca octandra	Inkweed	*													+		
Pilidiostigma glabrum						+		+							+		
Pinus nigra var. *corsicana*	Black Pine	*									+			+			
Pittosporum multiflorum	Orange Thorn			+	+												
Pittosporum undulatum	Sweet Pittosporum			+	+	+	+	+	+	+	+	+	+			+	
Plantago lanceolata	Lamb's Tongues	*		+													
Platycerium bifurcatum	Elkhorn			+	+						+						
Plectranthus parviflorus	Cockspur Flower			+													

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Podocarpus elatus	Plum Pine							+									
Protasparagus aethiopicus	Sprengeri Fern	*						+									
Prunus persica	Peach	*			+												
Prunus spp.														+			
Psidium cattleianum var. *cattleianum*		*						+									
Psilotum nudum	Skeleton Forked Fern							+									
Pteridium esculentum	Bracken			+		+									+		
Pyrrosia rupestris	Rock Felt Fern				+												
Quassia sp. 'Mt Nardi' (Floyd 1198)			r		+												
Rhodomyrtus psidioides	Native Guava							+									
Ripogonum album	White Supplejack															+	
Rivina humilis	Coral Berry	*							+								
Rubus rosifolius var. *rosifolius*	Rose-leaf Bramble			+	+			+							+		
Schefflera actinophylla	Umbrella Tree	*						+			+						
Senecio madagascariensis	Fireweed	*		+		+									+		
Senna floribunda		*			+												
Senna pendula var. *glabrata*	Cassia	*						+									
Sida rhombifolia	Paddy's Lucerne	*		+											+		+
Sigesbeckia orientalis ssp. *orientalis*	Indian Weed			+	+												
Sloanea australis	Maiden's Blush			+													
Smilax australis	Sarsaparilla				+	+										+	
Solanum capsicoides	Devil's Apple	*		+													
Solanum mauritianum	Wild Tobacco Bush	*		+		+		+	+						+	+	
Solanum nigrum	Black-berry Nightshade	*						+	+								
Solanum seaforthianum	Brazilian Nightshade	*							+								
Sonchus oleraceus	Common Sowthistle	*							+								
Stellaria media	Common Chickweed	*													+		
Stenotaphrum secundatum	Buffalo Grass	*		+													
Stephania japonica var. *discolor*	Snake Vine														+		
Sticherus flabellatus var. *flabellatus*	Umbrella Fern					+											

Species Name	Common Name	Exotic	Status	Patches (Site)													
				1	2	3	4	5	6	7	8	9	10	11	13	14	15
Syzygium moorei	Coolamon		v	+					+				+				
Syzygium spp.							+										
Taraxacum officinale	Dandelion	*															+
Tinospora tinosporoides	Arrow-head Vine		v	+					+						+	+	
Toechima dasyrrhache						+											
Toona ciliata	Red Cedar			+				+	+				+	+	+	+	
Tradescantia fluminensis	Wandering Jew	*		+					+								
Trema tomentosa var. *viridis*	Native Peach														+		
Trifolium repens	White Clover	*		+													
Trophis scandens ssp. *scandens*															+		
Verbena rigida	Veined Verbena	*															+
Verbena spp.		*						+									
Vicia sativa	Common Vetch	*				+											
Wahlenbergia gracilis	Sprawling or Australian Bluebell					+											
Waterhousea floribunda	Weeping Lilly Pilly												+				
Wikstroemia indica																	+
Wilkiea huegeliana	Veiny Wilkiea					+		+	+								
Wilkiea macrophylla	Large-leaved Wilkiea			+					+						+		

Key: * = exotic species

Status: R = ROTAP species, E = endangered species listed on the EPBC Act, V = vulnerable species listed on the EPBC Act, e = endangered species listed on the TSC Act, v = vulnerable species listed on the TSC Act

+ = Recorded at site

Appendix 4
Threatened Flora

This appendix details threatened plants recorded within 10 km of the study area or that have the potential to occur in the local area.

Threatened plant species listed under the TSC Act and/or EPBC Act that have previously been recorded or have potential habitat within a 10 km radius of the study area, based DECC Atlas of NSW Wildlife, Birds Australia Atlas and current survey

Latin Name	TSC Act	EPBC Act	Habitat Requirements	Likely to occur in study area?	Recorded along proposed upgrade (area of direct and /or indirect impact)
Acacia bakeri	V	-	In or near lowland subtropical rainforest, in adjacent eucalypt forest and in regrowth of both. Usually occurs in the understorey but may occur as a large canopy tree (DEC 2005…).	Yes – Lowland Rainforest.	No.
Acalypha eremorum	E1	-	Grows in subtropical and dry rainforest; north from Lismore district (Harden 1990).	Yes. Lowland Rainforest.	No.
Acronychia littoralis	E1	E	Found in littoral rainforest on sand (Harden 2002).	No littoral rainforest in study area.	No
Allocasuarina defungens	E1	E	Dwarf Heath Casuarina is found only in NSW from the Nabiac area, north-west of Forster, to Byron Bay on the NSW north coast. Dwarf Heath Casuarina grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains (DEC 2005b).	No tall heath in study area.	No
Amorphospermum whitei	V	-	Found in littoral and warm-temperate rainforest (Harden 1990) and the adjacent understorey of moist eucalypt forest. Rusty Plum occurs in the coast and adjacent ranges of northern NSW from the Macleay River into southern Queensland. Its distributional stronghold is on the mid north coast around Coffs Harbour (DEC 2005c). This species is considered to occur in a number of rainforest types, including subtropical rainforest (DEC 2005c).	Yes. Lowland Rainforest.	No
Archidendron hendersonii	V	-	From north Queensland south to the Richmond River in north-east NSW. It is found on a variety of soils including coastal sands and those derived from basalt and metasediments. Riverine and lowland subtropical rainforest and littoral rainforest (DEC 2005d).	Yes. Lowland Rainforest.	No
Arthraxon hispidus	V	V	Occurs over a wide area in south-east Queensland, and on the northern tablelands and north coast of NSW, but is never common. Also found from Japan to central Eurasia. Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps (DEC 2005f).	Yes. Lowland Rainforest.	No
Baloghia marmorata	V	V	In NSW, Jointed Baloghia is found in subtropical rainforest on soils derived from basalt (DEC 2005€).	Unlikely. Not previously recorded within 10 km of the study area.	No

Latin Name	TSC Act	EPBC Act	Habitat Requirements	Likely to occur in study area?	Recorded along proposed upgrade (area of direct and /or indirect impact)
Bosistoa selwynii	V	V	From Maryborough in Queensland south to the Tweed River district in north-east NSW. Occurs on deep asaltic soils. In NSW, it prefers alluvial flats, particularly creek banks. Rainforest up to 300 m in altitude (DEC 2005}).	Unlikely. Not previously recorded within 10 km of the study area.	No
Bosistoa transversa	V	V	Occurs north of Tweed River district where it grows in lowland rainforest to an altitude of 300 m (Harden 2002).	Unlikely. Not previously recorded within 10 km of the study area.	No
Chamaesyce psammogeton	E1	-	A coastal species which is found on foredunes and exposed headlands (NSW Scientific Committee 1998b) along the coast from south of Jervis Bay to Queensland (and Lord Howe Island). Populations have been recorded in Wamberal Lagoon Nature Reserve, Myall Lakes National Park and Bundjalung National Park. Flowering occurs in summer. *C. psammogeton* seeds float, so some dispersal between beaches may occur. Likes disturbed edges of tracks leading through foredunes (N.Smith pers. Comm.)	No	No
Corokia whiteana	V	V	Grows in warm-temperate rainforest on poorer soils; rare, known only from the Nightcap Range (Harden 1992). The inland populations are found at the boundaries between wet eucalypt forest and warm temperate rainforest, at altitudes up to 800 m (DEC 2005j). This species is considered to occur in a number of rainforest types, including subtropical rainforest (DEC 2005j).	Yes. Lowland Rainforest.	No
Cryptocarya foetida	V	V	Coastal south-east Queensland and north-east NSW south to Iluka. Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils. The seeds are readily dispersed by fruit-eating birds, and seedlings and saplings have been recorded from other habitats where they are unlikely to develop to maturity (DEC 2005š).	No littoral rainforest in study area	No
Davidsonia jerseyana (syn. *Davidsonia pruriens var. jerseyana*)	E1	E	Confined to subtropical rainforest in coastal areas from the Brunswick R. to the Tweed Valley (Harden 1990). Lowland subtropical rainforest and wet eucalypt forest at low altitudes (below 300m). Many trees are isolated in paddocks and on roadsides in former rainforest habitats (DEC 2005l).	Yes. Lowland Rainforest and Camphor Laurel.	No
Davidsonia johnsonii	E1	E	Disturbed subtropical rainforest or on the margins of wet sclerophyll forest and gully rainforest at low altitudes (below 300m) (DEC 2005•); from the Broken Head district to the Currumbin valley in southeast Queensland; (Syn. *Davidsonia sp. Mullumbimby-Currumbin Ck.*) (Harden and Williams 2000), (Harden 1990). Many trees are isolated in paddocks and on roadsides in cleared land (DEC 2005•).	Yes. Lowland Rainforest.	No

Latin Name	TSC Act	EPBC Act	Habitat Requirements	Likely to occur in study area?	Recorded along proposed upgrade (area of direct and /or indirect impact)
Desmodium acanthocladum	V	V	Grows mainly along rivers in Lismore-Grafton district (Harden 2002). Dry rainforest and fringes of riverine subtropical rainforest, on basalt-derived soils at low elevations. Much of its habitat has been cleared for agriculture (DEC 2005¢).	Yes. Lowland Rainforest.	No
Diospyros mabacea	E1	E	Occurs only in north-east NSW. It is found in a few stands on the Tweed and Oxley Rivers, upstream from Murwillumbah, on Stotts Island in the lower Tweed River and one other small population west of Mullumbimby on the Brunswick River. The largest population is in Limpinwood Nature Reserve. Usually grows as an understorey tree in lowland subtropical rainforest, often close to rivers. Soils are generally basalt-derived or alluvial (DEC 2005Ž).	Unlikely. Not previously recorded within 10 km of the study area.	No
Diploglottis campbellii	E1	E	Recorded from the coastal lowlands between Richmond River on the Far North Coast of NSW and Mudgeeraba Creek on the Gold Coast hinterland, Queensland. Confined to the warm subtropical rainforests of the NSW-Queensland border lowlands and adjacent low ranges. The forest types in which the species occurs vary from lowland subtropical rainforest to drier subtropical rainforest with a Brush Box open overstorey. Occurs on basalt-derived soils and also on poorer soils such as those derived from quartz monzonite (DEC 2005").	Yes. Lowland Rainforest and Camphor Laurel.	Yes, confirmed
Diuris sp aff *chrysantha*	E1	-	This orchid is known from a single location only, at Byron Bay in north-east NSW. Only about 20 plants have been recorded. Occurs in low-growing grassy heath on clay soil (DEC 2005n).	No	No
Drynaria rigidula	E1	-	Occurs widely in eastern Queensland as well as islands of the Pacific and parts of south-east Asia. In NSW it is only found north of the Clarence River, in a few locations at Maclean, Bogangar, Byron Bay, Mullumbimby, in the Tweed Valley and at Woodenbong. Grows on plants, rocks or on the ground. Usually found in rainforest but also in moist eucalypt and Swamp Oak forest (DEC 2005p).	Yes. Lowland Rainforest.	No
Elaeocarpus williamsianus	E1	E	Distribution is restricted to a very few sites between Goonengerry and Burringbar in north-east NSW. Subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing. Soils are derived from metasediments (DEC 2005|).	Yes. Lowland Rainforest and Camphor Laurel.	No
Endiandra floydii	E1	E	Confined to the Tweed and Brunswick Valleys and Byron Bay area of north-east NSW, and to one or two locations in south-east Queensland. Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest (DEC 2005k).	Yes. Lowland Rainforest.	No

Latin Name	TSC Act	EPBC Act	Habitat Requirements	Likely to occur in study area?	Recorded along proposed upgrade (area of direct and /or indirect impact)
Endiandra hayesii	V	V	A restricted distribution from Burleigh Heads in Queensland to the Richmond River in north-east NSW. It is locally abundant in some parts of its range in NSW. Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils (DEC 2005‘).	Yes. Lowland Rainforest.	No
Endiandra muelleri ssp. *bracteata*	E1	-	Occurs in Queensland and in north-east NSW south to Maclean. It is sparsely distributed within this range. Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes (DEC 2005u).	Yes. Lowland Rainforest.	No
Floydia praealta	V	V	Small scattered populations distributed from Gympie in Queensland to the Clarence River in north-east NSW. Riverine and subtropical rainforest, usually on soils derived from basalt (DEC 2005g).	Yes. Lowland Rainforest.	No
Fontainea oraria	E1	E	Grows in low littoral rainforest near Lennox Head (Harden 1990), on highly fertile red-brown krasnozem soils derived from the basalt. These remnants occur on stony slopes within 1 km of the sea and at about 50 m above sea level (DEC 2005i).	No littoral rainforest in study area and study area greater than 1 km from the sea.	No
Geodorum densiflorum	E1	-	There are thought to be less than 20 populations of Pink Nodding Orchid in NSW, all north of Bundjalung National Park, and including Tweed Shire. The species also occurs in Queensland. Occurs in dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand (DEC 2005w).	No	No
Gossia fragrantissima	E1	E	Grows in dry subtropical rainforest and riverine rainforest; coastal districts north from around Lismore (Harden 2002, DEC 2005œ). As it can coppice from roots left in the ground when rainforest is cleared, it is found at several sites as isolated plants in paddocks or regrowth (DEC 2005œ).	Yes. Lowland Rainforest.	No
Grevillea hilliana	E1	-	North from Brunswick Heads on the north coast of NSW and in Queensland. The only populations currently known in NSW are near Brunswick Heads and on the slopes of Mt Chincogan in Byron Shire and, in Tweed Shire in remnant patches of habitat, particularly around Terranora. White Yiel Yiel grows in subtropical rainforest, often on basalt-derived soils (DEC 2005z).	Yes. Lowland Rainforest.	No
Hibbertia hexandra	E1	-	Previously recorded from the ranges near Mt Warning. Also recorded near Wauchope where individuals have smaller leaves (Harden 1990). Tree Guinea Flower typically grows in heath, open forest or rainforest (DEC 2005~).	Yes. Lowland Rainforest.	No
Hicksbeachia pinnatifolia	V	V	Grows in subtropical rainforest, moist eucalypt forest and Brush Box forest. north from the Nambucca Valley, chiefly north of Lismore; often regenerates by suckering in disturbed sites (Harden 2002, DEC 2005‹).	Yes. Lowland Rainforest.	No

Latin Name	TSC Act	EPBC Act	Habitat Requirements	Likely to occur in study area?	Recorded along proposed upgrade (area of direct and /or indirect impact)
Isoglossa eranthemoides	E1	E	Collected only from the Tweed River and Booyong (near Lismore) (Harden 1992). Understorey of lowland subtropical rainforest, in moist situations on floodplains and slopes. Underlying soils are derived from basalt, metasediments or gabbro (DEC 2005).	Yes. Lowland Rainforest.	No
Macadamia tetraphylla	V	V	Subtropical rainforest in coastal areas north of the Clarence River, chiefly in the Richmond and Tweed Valleys (Harden 2002).	Yes. Lowland Rainforest.	Yes, confirmed
Marsdenia longiloba	E1	V	North from Coffs Harbour (Harden 1992). Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops (DEC 2005“).	Yes. Lowland Rainforest.	No
Melicope vitiflora	E1	-	Coast Euodia grows in subtropical and littoral rainforest. All populations are thought to be small (DEC 2005¤).	Yes. Lowland Rainforest.	No
Ochrosia moorei	E1	E	Tweed and Richmond R. districts (Harden 1992). Found in riverine and lowland subtropical rainforest (DEC 2005—).	Yes. Lowland Rainforest.	No
Owenia cepiodora	V	V	Subtropical and dry rainforest on or near soils derived from basalt, from Bangalow to McPherson Range (Harden 2002, DEC 2005‡).	Yes. Lowland Rainforest.	No
Phaius australis	E1	E	This terrestrial orchid is found in swamps dominated by *Melaleuca quinquenervia* and in sclerophyll forest (NSW Scientific Committee 1998c). Also occurs in swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas (DEC 2005˜).Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie (DEC 2005˜).	Yes. Lowland Rainforest.	No
Phaius tankervilliae	E1	E	This terrestrial orchid is found in coastal districts where it grows in *Melaleuca quinquenervia* swamps near sea level (Harden 1993).	No *Melaleuca quinquenervia* swamps in study area.	No
Phyllanthus microcladus	E1	-	In NSW confined to a few locations in the Tweed, Brunswick, Richmond and Wilson River Valleys with an outlying population near Grafton. Also occurs in south-east Queensland. Usually found on banks of creeks and rivers, in streamside rainforest (DEC 2005‰).	Yes. Lowland Rainforest.	No
Pterostylis nigricans	V	-	The Dark Greenhood occurs in north-east NSW north from Evans Head, and in Queensland. Grows in coastal heathland with Heath Banksia (Banksia ericifolia), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils (DEC 2005Š).	No	No
Randia moorei	E1	E	Grows in subtropical, riverine, littoral and dry rainforest; north from Lismore (Harden 1992, DEC 2005™). In NSW, Hoop Pine and Brush Box are common canopy species (DEC 2005™).	Yes. Lowland Rainforest.	No

Latin Name	TSC Act	EPBC Act	Habitat Requirements	Likely to occur in study area?	Recorded along proposed upgrade (area of direct and /or indirect impact)
Senna acclinis	E1	-	Found in coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland. Grows in or on the edges of subtropical and dry rainforest (DEC 2005').	Yes. Lowland Rainforest.	No
Sophora fraseri	V	V	Occurs north from the Casino district in north-east NSW, where it is very rare. Also in south-east Queensland where it is widespread but not common. Brush Sophora is usually found in moist situations, often near rainforest (DEC 2005–).	Yes. Lowland Rainforest.	No
Syzygium hodgkinsoniae	V	V	Grows in subtropical rainforest, gallery forest or riverine rainforest on rich alluvial or basaltic soils, north from the Richmond River (Harden 2002, DEC 2005).	Yes. Lowland Rainforest.	No
Syzygium moorei	V	V	Grows in lowland subtropical and riverine rainforest at low altitude, north from the Richmond River (Harden 2002, DEC 2005q). Often occurs as isolated remnant paddock trees (DEC 2005q).	Yes. Lowland Rainforest.	Yes, confirmed
Syzygium paniculatum	V	V	Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea (Harden 1991). Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DEC 2005¡). ROTAP 3VCi	Yes. Lowland Rainforest.	No.
Tinospora tinosporoides	V	V	Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils; north from the Richmond River (Harden 1990, DEC 2005e).	Yes. Lowland Rainforest.	Yes, confirmed
Xylosma terrae-reginae	E1	-	The Richmond River district in north-east NSW, north to the Maryborough region in Queensland. Rare in restricted habitat in NSW. Littoral and subtropical rainforest on coastal sands or soils derived from metasediments (DEC 2005§).	Yes. Lowland Rainforest.	No

Note: Species lists were compiled from the DEC Atlas of NSW Wildlife, online EPBC Database, relevant literature and from discussions with landowners.
Key: TSC Act - Endangered (E1), Vulnerable (V); EPBC Act – Endangered (E), Vulnerable (V)

Appendix 5
Animal Species Recorded During the Current Surveys

This appendix details animal species recorded in the study area during the current surveys.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Identification Method
Amphibians					
Bufonidae	*Bufo marinus*	Cane Toad		U	O
Hylidae	*Litoria peronii*	Peron's Tree Frog			W
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet			O
	Limnodynastes peronii	Striped Marsh Frog			O
	Limnodynastes tasmaniensis	Spotted Grass Frog			W
Birds - Native					
Accipitridae	*Aquila audax*	Wedge-tailed Eagle			O
	Elanus axillaris	Black-shouldered Kite			O
	Haliastur indus	Brahminy Kite			O
Anatidae	*Anas superciliosa*	Pacific Black Duck			O
Ardeidae	*Ardea ibis*	Cattle Egret	M		O
	Egretta novaehollandiae	White-faced Heron			O
	Nycticorax caledonicus	Nankeen Night Heron			O
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird			W
	Cracticus torquatus	Grey Butcherbird			O
	Grallina cyanoleuca	Magpie-lark			O
	Gymnorhina tibicen	Australian Magpie			OW
	Strepera graculina	Pied Currawong			O
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			O
Charadriidae	*Vanellus miles*	Masked Lapwing			O
Cinclosomatidae	*Psophodes olivaceus*	Eastern Whipbird			W
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove			O
	Macropygia amboinensis	Brown Cuckoo-Dove			W
	Ocyphaps lophotes	Crested Pigeon			O
Corvidae	*Corvus coronoides*	Australian Raven			W
	Corvus orru	Torresian Crow			O
Dicruridae	*Monarcha melanopsis*	Black-faced Monarch	M		OW
	Myiagra rubecula	Leaden Flycatcher			O
	Rhipidura fuliginosa	Grey Fantail			O
	Rhipidura leucophrys	Willie Wagtail			O
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra			W
Hirundinidae	*Hirundo neoxena*	Welcome Swallow			O
	Hirundo nigricans	Tree Martin			O
Maluridae	*Malurus cyaneus*	Superb Fairy-wren			O
	Malurus melanocephalus	Red-backed Fairy-wren			O
Megapodiidae	*Alectura lathami*	Australian Brush-turkey			O
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill			OW
	Anthochaera chrysoptera	Little Wattlebird			W
	Manorina melanocephala	Noisy Miner			O
	Meliphaga lewinii	Lewin's Honeyeater			W
Oriolidae	*Sphecotheres viridis*	Figbird			OW
Pachycephalidae	*Colluricincla megarhyncha*	Little Shrike-thrush			OW

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Identification Method
	Pachycephala pectoralis	Golden Whistler			W
Pardalotidae	*Acanthiza pusilla*	Brown Thornbill			O
	Gerygone olivacea	White-throated Gerygone			W
	Pardalotus punctatus	Spotted Pardalote			W
	Sericornis frontalis	White-browed Scrubwren			O
Passeridae	*Neochmia temporalis*	Red-browed Finch			O
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican			O
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin			W
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe			O
Psittacidae	*Alisterus scapularis*	Australian King-Parrot			O
	Platycercus eximius	Eastern Rosella			O
	Trichoglossus haematodus	Rainbow Lorikeet			W
Rallidae	*Fulica atra*	Eurasian Coot			O
	Porphyrio porphyrio	Purple Swamphen			O
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis			O
Tytonidae	*Tyto alba*	Barn Owl			O
	Tyto novaehollandiae	Masked Owl		V	W
Zosteropidae	*Zosterops lateralis*	Silvereye			O
Mammals - Native					
Macropodidae	*Wallabia bicolor*	Swamp Wallaby			O
Pteropodidae	*Pteropus alecto*	Black Flying-fox		V	O
	Pteropus poliocephalus	Grey-headed Flying-fox	V	V	O
Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat			AD
Vespertilionidae	*Miniopterus australis*	Little Bent-wing Bat		V	AD
	Myotis macropus	Large-footed Myotis		V	AM,AP
	Nyctophilus sp.	Long-eared bat			AD,AP
Reptiles					
Agamidae	*Physignathus lesueurii*	Eastern Water Dragon			O
Scincidae	*Tiliqua nigrolutea*	Blotched Blue-tongue Lizard			O

1: V = Vulnerable, E1 = Endangered, U = Unprotected, M = Migratory.

2: O = Observed, W = Heard, AD = Anabat Recording Definite Identification, AM = Anabat Recording Probable Identification, AP = Anabat Recording Possible Identification (codes based on NPWS reporting proformas).

Appendix 6: Threatened Fauna

This appendix details threatened animals recorded within 10 km of the Study Site or that have the potential to occur in the local area.

Threatened animal species listed under the TSC Act and/or the EPBC Act that have previously been recorded or have potential habitat within a 10 km radius of the study area

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Amphibians						
Assa darlingtoni	Pouched Frog	V	-	Inhabits Antarctic Beech forest and rainforest in mountainous areas. These frogs do not need free water for breeding, as eggs are laid on the ground. They spend most of the time in damp leaf litter, or under rocks and rotten logs (Robinson 1993).	Yes	No
Crinia tinnula	Wallum Froglet	V	-	Found in acid *Melaleuca* swamps and wallum areas with poor drainage (Barker *et al.* 1995). Breeds in late winter (Cogger 1992).	No	No
Litoria aurea	Green and Golden Bell Frog	E1	V	Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes (NPWS 1999d). Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (White and Pyke 1996, NPWS 1999d).	Yes	No
Litoria olongburensis	Olongburra Frog	V	V	The Olongburra Frog is only known from well vegetated acid swamps and streams on coastal sand masses (Tyler and Australia. 1997).	No	No
Native Birds						
Amaurornis olivaceus	Bush-hen	V	-	Occurs in swamps, flooded grasslands and rainforest fringes (Simpson and Day 1996).	Yes	No
Anseranas semipalmata	Magpie Goose	V	-	Found in floodplains and swamps dominated by sedges and rushes (Simpson and Day 1996).	Yes	No
Ardea ibis	Cattle Egret		M	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1993b).	Yes	Yes
Botaurus poiciloptilus	Australasian Bittern	V	-	Inhabits terrestrial and estuarine wetlands, generally where there is permanent water. Prefers wetlands with dense vegetation including rushes and reeds (NPWS 1999a).	No	No
Burhinus grallarius	Bush Stone-curlew	E1	-	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993a).	No	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Calyptorhynchus banksii	Red-tailed Black-cockatoo	V	E	Occur in a wide variety of habitats, but prefer eucalypt forest and woodland, and often in adjacent *Acacia* or *Casuarina* woodland or proteaceous woodland or shrubland, especially if recently burnt (Higgins 1999). In the arid zone they usually occur on open riverine plains, mainly near eucalypts along major watercourses, but also associated with *Casuarina* woodlands nearby. They breed in the hollows of large trees, mainly dead eucalypts (Higgins 1999).	No	No
Calyptorhynchus lathami	Glossy Black-cockatoo	V	E	Inhabits forest with low nutrients, characteristically with key *Allocasuarina* species. Tends to prefer drier forest types (NPWS 1999c) with a middle stratum of *Allocasuarina* below *Eucalyptus* or *Angophora*. Often confined to remnant patches in hills and gullies (Higgins 1999). Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	No	No
Coracina lineata	Barred Cuckoo-shrike	V	-	Found in rainforests, vine thickets and their margins. Also found in eucalypt forests and clearing in secondary growth forests (Pizzey and Knight 1997)	Yes	No
Cyclopsitta diophthalma	Coxen's (Double-eyed) Fig-Parrot	E1	E	Preferred habitat is subtropical rainforest but also occurs in dry rainforest and cool subtropical rainforest. Lives in the canopy of dense rainforest (Lunney *et al.* 2000).	Yes	No
Dromaius novaehollandiae	Emu	E2	-	Endangered Population: NSW North Coast Bioregion and Port Stephens LGA	No	No
Ephippiorhynchus asiaticus	Black-necked Stork	E1	-	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey 1983).	Yes	No
Erythrotriorchis radiatus	Red Goshawk	E1	VM	Occur in forest and woodland habitat near permanent water. In NSW prefer *Melaleuca* swamp forest and open eucalypt woodland (Marchant & Higgins 1993). Require greater than 20 m tall for nesting (Marchant and Higgins 1993b).	Yes	No
Gallinago hardwickii	Latham's Snipe	-	M	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	Yes	No
Grus rubicunda	Brolga	V	M	The Brolga has been recorded on open wetlands, shallow swamps, floodplains, paddocks, farmland and salt flats (NPWS 1996). This species nest in shallow wetlands where there is shelter such as canegrass, lignum or sedge swamp. They feed in or near water and have often been observed foraging in grassland, dry wetlands and cultivated areas (NPWS 1996).	Yes	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Haliaeetus leucogaster	White-bellied Sea-eagle		M	A migratory species that is resident to Australia. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes (English and Predavec 2001).	Yes	No
Hirundapus caudacutus	White-throated Needletail		M	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzey 1983).	Yes	No
Irediparra gallinacea	Comb-crested Jacana	V	-	Occurs in freshwater wetlands, lagoons, Billabongs, swamps, lakes, rivers and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1993b).	Yes	No
Ixobrychus flavicollis	Black Bittern	V	-	Usually found on coastal plains below 200 m. Often found along timbered watercourses, in wetlands with fringing trees and shrub vegetation. The sites where they occur are characterized by dense waterside vegetation (NPWS 1999b).	Yes	No
Lathamus discolor	Swift Parrot	E1	EM	The Swift Parrot occurs in woodlands and forests of New South Wales from May to August, where it feeds on eucalypt nectar, pollen an associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitat in its wintering grounds in New South Wales (Shields and Crome 1992). This species is migratory breeding in Tasmania and also nomadic moving about in response to changing food availability (Pizzey 1983).	No	No
Lichenostomus fasciogularis	Mangrove Honeyeater	V	-	The Mangrove honeyeater is confined to the coastal fringe and offshore islands of eastern Australia from the Townsville area, Queensland south to the NSW north coast. It is common in Queensland but rare in NSW, where a few colonies exist at scattered localities, including the Tweed, Richmond and Clarence River estuaries and Stuarts Point south of Macksville. Its primary habitat is mangrove forest but the species also occurs in other near-coastal forests and woodlands, including casuarina and paperbark swamp forests. It sometimes frequents adjacent shrublands and woodlands dominated by banksias and eucalypts. It sometimes visits gardens in coastal towns (NPWS 2001a).	No	No
Lophoictinia isura	Square-tailed Kite	V	M	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993b). In NSW it is often associated with ridge and gully forests dominated by Woollybutt *Eucalyptus longifolia*, Spotted Gum *Corymbia maculata* or Peppermint Gum *E. elata, E. smithii* (NPWS 1999h).	Yes	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Monarcha leucotis	White-eared Monarch	V	-	Occurs in rainforest, sometimes mangroves and paperbark swamps (Lunney *et al.* 2000).	Yes	No
Monarcha melanopsis	Black-faced Monarch	-	M	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey 1983).	Yes	Yes
Monarcha trivirgatus	Spectacled Monarch	-	M	Found in darker parts of mountain and lowland rainforest, adjacent to thickly wooded gullies (Pizzey 1983).	Yes	No
Myiagra cyanoleuca	Satin Flycatcher	-	M	Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey 1983).	Yes	No
Pandion haliaetus	Osprey	V	M	Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found up larger rivers (Pizzey 1983).	No	No
Pezoporus wallicus	Ground Parrot	V	-	Mainly found in heathland, sedgeland or buttongrass plains providing medium to dense cover (Higgins 1999).	No	No
Podargus ocellatus	Marbled Frogmouth	V	-	Occurs in rainforests with palms (Simpson and Day 1996).	Yes	No
Poephila cincta	Black-throated Finch	E1	V	Occupies woodland savannah and riverine vegetation. The preferred inland habitat is grassy woodlands, dominated by seeding grasses, *Eucalyptus* spp., *Melaleuca* spp. or *Acacia* spp., with access to water. Nearer to the coast, the species has been recorded in open grassy plains with pandanus (Lunney *et al.* 2000).	No	No
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V	-	Occurs in drier, more open forests, scrubby woodlands, trees bordering roads, farmland with isolated trees (Simpson and Day 1996).	No	No
Ptilinopus magnificus	Wompoo Fruit-dove	V	-	Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Higgins and Davies 1996).	Yes	No
Ptilinopus regina	Rose-crowned Fruit-dove	V	-	Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands (Higgins and Davies 1996).	Yes	No
Ptilinopus superbus	Superb Fruit-dove	V	-	Mostly closed forests, including monsoon rainforests and mesophyll vine forests (Higgins and Davies 1996).	Yes	No
Puffinus carneipes	Flesh-footed Shearwater	V	M	Oceanic species found in coastal areas on the east and west coasts (Simpson and Day 1996).	No	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Rhipidura rufifrons	Rufous Fantail	-	M	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey 1983).	Yes	No
Rostratula benghalensis	Painted Snipe	V	VM	Found in the fringes of swamps, dams, sewage farms, marshy areas, generally with cover of grasses, lignum or open timber (Pizzey and Knight 1997).	Yes	No
Stagonopleura guttata	Diamond Firetail	V		Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs {Pizzey, 1997 435 /id}. Often occur in vegetation along watercourses {Higgins, 2006 8535 /id}.	Yes	No
Stictonetta naevosa	Freckled Duck	V	M	The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).	Yes	No
Todiramphus chloris	Collared Kingfisher	V	-	Occurs in mangroves and coastal areas (Simpson and Day 1996).	No	No
Turnix maculosa	Red-backed Button-quail	V		Red-backed Button-quail inhabit grasslands, woodlands and cropped lands of warm temperate areas that annually receive 400 mm or more of summer rain (Marchant and Higgins 1993). Observations of populations in other parts of its range suggest the species prefers sites near water, including grasslands and sedgelands near creeks, swamps and springs, and wetlands. Red-backed Button-quail usually breed in dense grass near water, and nests are made in a shallow depression sparsely lined with grass and ground litter.	Yes	No
Turnix melanogaster	Black-breasted Button-quail	E1	V	Within NSW, the species inhabits areas with an elevation of 200 to 700 m, in dry or subtropical rainforests which contain brigalow, belah, bottle trees, hoop pine, lantana, ironbark, wattle, spotted gum, wallaby grass or Rhodes grass (Lunney *et al.* 2000).	No	No
Tyto capensis	Grass Owl	V	-	Occurs mainly in open tussock grassland, usually in treeless areas. Can also occur in marshy areas with tall dense tussocks of grass. Occasionally occurs in densely vegetated agricultural lands such as sugarcane fields (Higgins 1999).	Yes	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometime dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked owls do prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997, Higgins 1999).	Yes	Yes
Tyto tenebricosa	Sooty Owl	V	-	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude <500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 cm in diameter (Gibbons and Lindenmayer 1997).	Yes	No
Xanthomyza phrygia	Regent Honeyeater	E1	E	A semi-nomadic species occurring in temperature eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forests associations and wet lowland coastal forests (Pizzey 1983, NPWS 1999f).	No	No
Native Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998).	Yes	No
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, and abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995).	Yes	No
Miniopterus australis	Little Bent-wing Bat	V	-	Shows a preference for well timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. Roost in caves, congregating into maternity colonies in summer months (Churchill 1998).	Yes	Yes

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Miniopterus schreibersii	Eastern Bent-wing Bat	V	-	Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts (Strahan 1995).	Yes	No
Myotis macropus	Large-footed Myotis	V	-	Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards 1995, Churchill 1998).	Yes	Yes
Nyctimene robinsoni	Eastern Tube-nosed Bat	V		Occupies streamside habitats within coastal subtropical rainforest and moist eucalypt forests with a well-developed understorey (NPWS, 2002). They are important pollinators and dispersers of native trees (Churchill, 1998). This species roosts in the foliage of canopy and understorey trees during the day. In NSW, they usually forage within 200 m of their day roost (Churchill, 1998).	Yes	No
Nyctophilus bifax	Eastern Long-eared Bat	V	V	Favours wetter habitats, ranging from rainforest and monsoon forest to riverine forests of paperbark, but are also found in open woodland, tall open forest and dry sclerophyll woodland. In northern NSW they are restricted to rainforest. The species have been recorded roosting under peeling bark, among epiphytes, in tree hollows, in the roots of strangler figs, amongst the dead fronds of a prickly tree fern and in foliage (Churchill 1998).	Yes	No
Phascolarctos cinereus	Koala	V	-	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990, Reed *et al.* 1990).	Yes	No
Planigale maculata	Common Planigale	V	-	Inhabits a range of habitats from rainforest, sclerophyll forest and grasslands to marshlands and rocky areas (Redhead 1995).	Yes	No
Potorous tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston 1995).	Yes	No
Pteropus alecto	Black Flying-fox	V	-	Occupies a wide range of tropical and subtropical forest and woodland habitats. They roost on trees, commonly in mangroves, rainforest, monsoon and paperbark forests (Churchill 1998).	Yes	Yes

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Requirements	Potential habitat within study area?	Recorded in study area
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	Yes	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill 1998)In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Richards 1995). This species roosts in hollow tree trunks and branches (Churchill 1998).	Yes	No
Syconycteris australis	Common Blossom-bat	V	-	Require a combination of heathland and coastal rainforest. In northern Queensland they occur in rainforest and paperbark forest (Churchill 1998).	Yes	No
Reptiles						
Coeranoscincucs reticulatus	Three-toed Snake-tooth Skink	V	V	The Three-toed Snake-tooth Skink occurs in the coast and ranges from the Macleay valley in NSW to south-eastern Queensland. It is very uncommon south of Grafton. Its habitat includes rainforest and occasionally moist eucalypt forest, on loamy or sandy soils. The Three-toed Snake-tooth Skink lives in loose soil, leaf litter and rotting logs, and feeds on earthworms and beetle grubs (NPWS 2001d).	Yes	No
Invertebrates						
Thersites michellae	Mitchell's Rainforest Snail	E1	Z	Mitchell's Rainforest Snail occurs in coastal areas of undisturbed moist forest, rainforest, and wet sclerophyll forest. It is semi-arboreal and can be found under bark on tree trunks and in the base of palm fronds (NPWS 2001c).	Yes	No

Note: Species lists were compiled from the DEC Atlas of NSW Wildlife, Byron and Ballina Council records, relevant literature and from discussions with landowners.

Key: TSC Act - Endangered (E1), Endangered Population (E2), Vulnerable (V); EPBC Act – Critically Endangered (Z), Endangered (E), Vulnerable (V), or Migratory (M)

Appendix 7

TSC Act Impact Assessment: Threatened Species and Endangered Ecological Community profiles

Contents

Flora

Impact assessments are required for 36 plant species listed under the TSC Act: *Acacia bakeri, Acalypha eremorum, Amorphospermum whitei, Archidendron hendersonii, Arthraxon hispidus, Corokia whiteana, Davidsonia jerseyana, D. johnsonii, Desmodium acanthocladum, Diploglottis campbellii, Drynaria rigidula, Elaeocarpus williamsianus, Endiandra floydii, E. hayesii, E. muelleri* ssp. *bracteata, Floydia praealta, Gossia fragrantissima, Grevillea hilliana, Hibbertia hexandra, Hicksbeachia pinnatifolia, Isoglossa eranthemoides, Macadamia tetraphylla, Marsdenia longiloba , Melicope vitiflora, Ochrosia moorei, Owenia cepiodora, Phaius australis, Phyllanthus microcladus, Randia moorei, Senna acclinis, Sophora fraseri, Syzygium hodgkinsoniae, S. moorei, S. paniculatum, Tinospora tinosporoides* and *Xylosma terrae-reginae.* The potential impact of the proposed upgrade on the above listed threatened species is assessed in the species profiles below.

Acacia bakeri

Description

Acacia bakeri is a tree of 5 – 30 m with wrinkled bark and a rounded canopy that is much darker and denser than that of most wattles. Its curved leaves are broad and dark green, with three to four prominent longitudinal veins, and thickened veins around the edges. The flower heads are small, round, and pale or golden yellow, and are followed by large bunches of flat, brown seed-pods containing several black seeds (DEC 2005…).

Conservation status

Acacia bakeri is listed as Vulnerable on the TSC Act.

There is at least one recoding of this species in a conservation reserve in the region: Mooball National Park (DEC 2007). Most plants are on private property (DEC 2005…). The species is not considered to be adequately represented in conservation reserves.

Habitat requirements

The species is known to occur in or near lowland subtropical rainforest, in adjacent eucalypt forest and in regrowth of both. Usually occurs in the understorey but may occur as a large canopy tree (DEC 2005…).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: loss of habitat through land development and

agriculture; invasion by weeds, particularly Lantana; fire, which kills adult trees and encourages weed growth; and visitor impacts in high use areas (DEC 2005…).

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Acacia bakeri* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Acacia bakeri.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Acacia bakeri*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date no Recovery Plan or Threat Abatement Plan has been written for this species. The DECC lists recovery actions for the species (DEC 2005…). Those that are relevant to the proposed upgrade are listed below:

- Control fire in areas of known or potential habitat – the proposed upgrade is not likely to alter the fire frequency within the local area.
- Assist in control and removal of weeds from rainforest areas – a Vegetation Management Plan written for the proposed upgrade should take into account requirements of this species and any required weed control works.
- Protect areas of rainforest and adjoining eucalypt forest from clearing and development – approximately 2.0 ha of Lowland Rainforest will be cleared for the proposed upgrade.

The proposed upgrade is not likely to impact on the recovery of the species, as the species is not known to occur in the study area and no known areas of habitat would be impacted.

Local and regional abundance

A total of 227 known records of the species occur in NSW, mostly to the north of

Ballina in the Byron Bay and Tweed areas (DEC 2007).

Twenty eight records of the species occur within a 10 km radius of the study area, mostly occurring to the north-west of the study area.

Locations relative to limits of distribution

The species is restricted to coastal south-east Queensland and north-east NSW, where it occurs north from Mullumbimby (DEC 2005…). The study area is considered to be at the limit of the species distribution.

Habitat (within study area)

Habitat within the study area is within Lowland Rainforest. The species has not been recorded within the study area.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest, which is potential habitat for the species would be removed (from 776 ha within the Locality (NPWS 1997b)). This represents 0.3 % of potential habitat that occurs within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification in the study area. However, this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented.

Given that the species was not recorded in the study area, only 0.3% of potential habitat for this species in the Locality would be directly impacted and fragmentation would not be increased, it is considered unlikely that a viable

local population of *Acacia bakeri* would be placed at risk of extinction by the proposed upgrade.

Acalypha eremorum

Description

Acalypha eremorum is an open-branched twiggy-looking shrub 2 – 4 m tall. The branches have conspicuous raised spots and often bear spines at the tips. The rounded, almost stalkless leaves are 0.3 – 3.5 cm long, with blunt teeth and five to seven veins on each side of the midrib. They are paler below and when young may be softly hairy. In drought the plant is often completely leafless. Tiny male and female flowers occur separately, but on the same plant. The fruits are globular, though somewhat flattened, capsules about 3 mm in diameter (DEC 2005a).

Conservation status

Acalypha eremorum is listed as Endangered on the TSC Act.

There are five records of the species in the Clarence Valley area, all within Chaelundi National Park. There is also a recording of the species in the Murwillumbah area within Mooball National Park (DEC 2007). The species is not considered to be adequately represented in conservation reserves.

Habitat requirements

The species occurs within subtropical rainforest, dry rainforest and vine thickets (DEC 2005a).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: browsing and trampling by cattle; fire; clearing of habitat; weed infestation, particularly by Lantana; and, trampling by visitors (DEC 2005a).

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Acalypha eremorum* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Acalypha eremorum.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Acalypha eremorum*.
- Invasion of native plant communities by exotic perennial grasses – it is

possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara - Acalypha eremorum* is listed as a species threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date no Recovery Plan or Threat Abatement Plan has been written for this species. The DECC lists recovery actions for the species (DEC 2005a). Those that are relevant to the proposed upgrade are listed below:

- Remove weeds where they threaten adult plants or regeneration– a Vegetation Management Plan written for the proposed upgrade should take into account requirements of this species and any required weed control works.

- Protect areas of rainforest from clearing and development – approximately 2.0 ha of Lowland Rainforest will be cleared for the proposed upgrade.

The proposed upgrade is unlikely to impact on the recovery of the species, as the species is not known to occur in the study area and no known areas of habitat would be impacted.

Local and regional abundance

A total of 10 records of the species occur in NSW, located to the north of Ballina near Murwillumbah, two west of Byron Bay and further south in the Clarence Valley Area (DEC 2007).

Four records of the species occur within a 10 km radius of the study area, occurring approximately 2 km to the west of the study area(Figure 3). These records do not have any count information.

Locations relative to limits of distribution

The species is widespread in Queensland, but in NSW the species occurs in only a few localities, including the Chaelundi, Lismore and Burringbar areas (DEC 2005a). According to the data on the Atlas of NSW Wildlife (DEC 2007), there are three distinct populations of *Acalypha eremorum* within NSW, one to the north of Ballina near Murwillumbah, two west of Byron Bay and one further south in the Clarence Valley Area. The study area is not considered to be at the limit of the

species distribution.

Habitat (within study area)

Habitat within the study area is within Lowland Rainforest. The species has not been recorded within the study area.

Habitat for the species in the study areaoccurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest, which is potential habitat for the species would be removed (from 776 ha within the Locality (NPWS 1997b)). This represents 0.3 % of potential habitat that occurs within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification in the study area. However, this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented.

Given that the species was not recorded in the study area, only 0.3% of potential habitat for this species in the Locality would be directly impacted and fragmentation would not be increased, it is considered unlikely that a viable local population of *Acalypha eremorum* would be placed at risk of extinction by the proposed upgrade.

Amorphospermum whitei

Description

Amorphospermum whitei is a small to medium-sized tree to 20 m high with a very

fluted or irregular trunk. The young shoots have rusty hairs, and the shoots and stems exude white milky sap if cut. The leaves are alternate, 5 - 15 cm long and 2 - 5 cm wide with a firm texture and a 'quilted' appearance. The undersurface of the leaves is paler than the upper surface and has prominent raised veins, including 15 to 20 pairs of curved secondary veins. Creamy green flowers form in clusters of four to 15 on the stems in spring. The Rusty Plum has globular plum-like fruit approximately 2 -5 cm in diameter and turn from red to black upon maturity. The round seed inside is very shiny, with an elliptical scar on one side (DEC 2005c).

Conservation status

Amorphospermum whitei is listed as Vulnerable on the TSC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3RCa, indicating:

3 = A geographic range of >100 km

R = Rare species

C = Reserved, with a least one population in a national park

a = adequately reserved (> 1000 plants)

Amorphospermum whitei occurs in the following conservation reserves in northern NSW: Numinbah Nature Reserve, Nightcap National Park, Whian Whian State Conservation Area and Broken Head Nature Reserve (DEC 2007).

Habitat requirements

Amorphospermum whitei occurs in rainforest and the adjacent understorey of moist eucalypt forest (DEC 2005c).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: clearing of habitat for development; timber harvesting activities; and, invasion of habitat by introduced weeds, particularly Lantana (DEC 2005c).

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Amorphospermum whitei* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Amorphospermum whitei.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential

habitat for*Amorphospermum whitei*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara - Amorphospermum whitei* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date no Recovery Plan has been written for this species. The DECC lists recovery actions for the species (DEC 2005c). Those that are relevant to the proposed upgrade are listed below:

- Assist with the control and removal of weeds – a Weed Management Plan, as part of the Vegetation Management Plan should be written for areas where the species is known to occur in the study area.

- Protect rainforest and moist forest habitat from development – potential habitat for this species will be cleared for the proposed upgrade.

Local and regional abundance

A total of 194 known records of the species occur in NSW, most of which occur in the Coffs Harbour area, with a few scattered records around the Byron Bay and Tweed Heads area (DEC 2007).

Thirty five records of *Amorphospermum whitei* occur within a 10 km radius of the study area (Figure 3), the closest of which occurs approximately 5 km to the east of the study area. Two of these records have count information, both supporting one plant each (DEC 2007).

Locations relative to limits of distribution

Amorphospermum whitei occurs in the coast and adjacent ranges of northern NSW from the Macleay River into southern Queensland. Its distributional stronghold is on the mid north coast around Coffs Harbour. The study area is not at the limit of known distribution for the species.

Habitat (within study area)

The species has not been recorded in the study area, though habitat within the study area is in Lowland Rainforest, occurring as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is unlikely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of habitat for this species would be removed (from approximately 776 ha in the Locality (NPWS 1997b)). This represents 0.3 % of potential habitat within the Locality.

No known records of the species would be directly impacted by the proposed upgrade.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank and disrupting recruitment within the potential habitat in the study area. However, this is unlikely as the species was not recorded in the study area.

The proposed upgrade would not result in additional fragmentation of habitats in the study area, as it generally follows the path of the existing Pacific Highway. Further, the patches of vegetation in the study area are small and fragmented, with only the edges impacted by the proposed upgrade. The impacts of fragmentation are therefore likely to be minor.

Given that the species was not recorded in the study area, only 0.3% of potential habitat for this species in the Locality would be directly impacted, fragmentation would not be increased and the number of records of the species in the local area, it is considered unlikely that a viable local population of *Amorphospermum whitei* would be placed at risk of extinction by the proposed upgrade.

Archidendron hendersonii

Description

According to the DECC threatened species profile (DEC 2005d), *Archidendron hendersonii* is a tree to 18 m tall, with light-brown bark. Its leaves are bipinnate with glossy hairless leaflets separated unequally by the midvein. Up to ten fragrant, fluffy creamy-white flowers are bunched in heads. Woody orange pods develop, splitting and curling to reveal glossy black seeds displayed against the red or yellow interior of the pod.

Conservation status

Archidendron hendersonii is listed as Vulnerable on the TSC Act.

Archidendron hendersonii is known to occur in three conservation reserves (NSW Scientific Committee 2000a): Cape Byron State Conservation Area, Brunswick Heads Nature Reserve and Marshalls Creek Nature Reserve (DEC 2007). These reserves all occur in the Byron LGA. The majority of individuals within the Ballina area occur outside conservation reserves and remain under threat from development pressure.

Habitat requirements

The species occurs on a variety of soils including coastal sands and those derived from basalt and metasediments (DEC 2005d). Habitat for *Archidendron hendersonii* occurs in riverine and lowland subtropical rainforest and littoral rainforest (DEC 2005d).

Although *Archidendron hendersonii* flowers and fruits well, it is often represented by only single trees per stand, and seedlings are rare (NSW Scientific Committee 2000a). Given the small size of the known populations, and the small size of the stands of rainforest in which they are found *Archidendron hendersonii* is at risk from further fragmentation of rainforest and from degradation of stands from weed invasion and disturbance (NSW Scientific Committee 2000a).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: loss of habitat through clearing and fragmentation; habitat degradation through weed invasion and disturbance; and illegal collection of seeds for horticulture (DEC 2005d).

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Archidendron hendersonii* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Archidendron*

hendersonii.

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Archidendron hendersonii*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara* - *Archidendron hendersonii* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date no Recovery Plan or Threat Abatement Plan has been written for this species. The DECC lists recovery actions for the species (DEC 2005d). Those that are relevant to the proposed upgrade are listed below:

- Ensure that managers are aware of populations and habitat and that PoMs, fire plans and pest management plans take account of requirements for the recovery of *Archidendron hendersonii* – a Vegetation Management Plan written for the study area should take into account requirements of this species.

- Survey before road and track maintenance in the habitat of the species, protect road and trackside plants – no known records of *Archidendron hendersonii* occur within the subject site.

- Assess weed threats to populations, manage as necessary – a Weed Management Plan, as part of the Vegetation Management Plan should be written for areas where the species is known to occur in the study area.

Local and regional abundance

A total of 58 known records of the species occur in NSW, most of which occur in the Ballina, Byron Bay and Tweed LGA's (DEC 2007). There is also a record of the species to the south in the Coffs Harbour area and to the west in the Lismore area (NSW Government 2007).

Forty six records of *Archidendron hendersonii* occur within a 10 km radius of the study area (Figure 3), a number of which occur within 1 km of the subject site.

Only 12 of these records have count information, each supporting between one and five plants.

Locations relative to limits of distribution

The species has a distribution from north Queensland south to the Richmond River in north-east NSW (DEC 2005d). According to the data on the Atlas of NSW Wildlife (DEC 2007), populations of *Archidendron hendersonii* within the Locality are near the southernmost limit of the species distribution.

Habitat (within study area **)**

Habitat within the study area includes Lowland Rainforest. This species was not recorded in the study area, however previous records of the species exist in nearby areas in patches of Lowland Rainforest and Camphor Laurel.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is unlikely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of habitat for this species would be removed (from approximately 776 ha in the Locality (NPWS 1997b)). This represents 0.3 % of potential habitat within the Locality. No known records of the species would be impacted by the proposed upgrade.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disruption of the breeding cycle, disturbance to the soil seed bank and disrupting recruitment within the habitat in the study area. These impacts to the lifecycle of the species are not likely to significantly impact the local population given no known records are likely to be impacted and the fact that the patches of habitat that would be impacted are in poor condition and are not likely to be important to the ongoing survival of the specie in the local area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented.

Given that 0.3% of potential habitat for this species in the Locality would be directly impacted by the proposed upgrade, fragmentation would not be increased and the number of records of the species in the local area, it is considered unlikely that a viable local population of *Archidendron hendersonii* would be placed at risk of extinction by the proposed upgrade.

Arthraxon hispidus

Description

Based on the DECC threatened species profile (DEC 2005f), *Arthraxon hispidus* is a creeping grass with branching, erect to semi-erect purplish stems. Leaf-blades are 2–6 cm long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. This grass is considered to be a perennial but it tends to die down in winter.

Conservation status

Arthraxon hispidus is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VC-+, indicating:

3 = A geographic range of >100 km

V =Vulnerable species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

+ = Species with natural distributions outside Australia

There are seven known records of the species in NSW (DEC 2007), none of which are within conservation reserves. It is therefore assumed that this species is not adequately represented in conservation reserves.

Habitat requirements

Little information is available on the breeding cycle of *Arthraxon hispidus.* On the basis that this species roots at the lower nodes (Royal Botanic Gardens Sydney 2006), it is assumed that reproduction is both asexual and by seed. As with other

grasses, this species is assumed to be wind pollinated.

The species is a moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps (DEC 2005f). The species is not considered to be common across its range (DEC 2005f).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: clearing of habitat for agriculture and development; inappropriate fire regimes; over-grazing by domestic stock; competition from introduced grasses such as Paspalum and Kikuyu; and slashing or mowing of habitat (DEC 2005{).

Key Threatening Processes listed on the TSC Act that are relevant to the proposed upgrade and that may impact on potential habitat for *Arthraxon hispidus* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Arthraxon hispidus.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Arthraxon hispidus*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara - Arthraxon hispidus* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, as a precaution, weed control works should be detailed in a Vegetation Management Plan.

To date, no Recovery Plan or Threat Abatement Plan has been prepared for *Arthraxon hispidus.* The DECC (DEC 2005f) has identified a number of priority actions to help the recovery of this species. Those that are relevant to the proposed upgrade are detailed below:

- Protect habitat from frequent fire – the proposed upgrade is not likely to increase fire frequency in the local area.
- Avoid slashing or mowing around rainforest edges – the requirements of the

species should be considered in the preparation of the Vegetation Management Plan.

- Control introduced grasses in areas with known populations – there are no known populations within the subject site. The closest known record of the species occurs approximately 1.5 km to the south of the subject site in a small fragmented patch of Lowland Rainforest.
- Protect areas of rainforest, wet eucalypt forest and swamp from clearing and development – the proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known records of the species would be impacted.

Local and regional abundance

There are seven known records of the species in NSW (DEC 2007), two of which occur in the Ballina LGA, three in the north-west of the state in the Tenterfield/Glen Innes Severn area and one in the Coffs Harbour Area. There are numerous additional records of the species on the Bionet database (NSW Government 2007) in an area bounded by Tweed, Tenterfield and Kempsey.

Three known records of this species occur within 10 km of the study area. The closest of these records occurs approximately 1.5 m to the south of the subject site within a small and isolated patch of Lowland Rainforest. Two additional records of this species occur in the Locality outside the study area, approximately 7 km south-west of Tintenbar (Figure 3).

Locations relative to limits of distribution

The population of *Arthraxon hispidus* within the Locality is not at the known limit of the species distribution, with records further south in the Coffs Harbour and Kempsey areas, further west in the Tenterfield area and further north in southern Queensland (DEC 2005f, 2007, NSW Government 2007).

Habitat (within study area**)**

This species has previously been recorded approximately 1.5 m to the south of the subject site within a small and isolated patch of Lowland Rainforest. There are no known records of the species within patches of vegetation present in the study area.

Habitat for this species within the study area includes Lowland Rainforest. This habitat occurs as small, fragmented stands. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented

nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Arthraxon hispidus was not detected during field surveys within the study area. Approximately 2.0 ha of potential habitat would be removed (from approximately 776 ha within the Locality (NPWS 1997b)). This represents 0.3 % of potential habitat within the Locality (10 km radius of the study area).

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank and disrupting recruitment within the potential habitat in the study area. However, this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat for this species within the local area would be directly impacted by the proposed upgrade, the fact that the species was not recorded during field surveys, and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species, it is considered unlikely that a viable local population of *Arthraxon hispidus* would be placed at risk of extinction by the proposed upgrade.

Corokia whiteana

Description

Corokia whiteana is a shrub or small tree to 4 m tall. Its young shoots, branches and flowers are scattered with hairs, which are sparser on older leaves, and mainly on the undersurface. The leaves, some of which are toothed, are mostly 2 – 7 cm long

and 2 – 20 mm wide, tapering to the apex. The cream-coloured flowers are scented and held in loose clusters. Flowers are followed by red, fleshy fruits, 8 – 12 mm long, usually with a single spindle-shaped seed (DEC 2005j).

Conservation status

Corokia whiteana is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2VCi, indicating:

2 = A geographic range of <100 km

V =Vulnerable species

C = Reserved, with a least one population in a national park

i = inadequately reserved (<1000 plants)

There are 80 known records of the species in NSW (DEC 2007), some of which occur in the following conservation reserves: Billinudgel Nature Reserve, Mount Jerusalem National Park, Whian Whian State Conservation Area and Nightcap National Park.

Habitat requirements

The inland populations of *Corokia whiteana* are found at the boundaries between wet eucalypt forest and warm temperate rainforest, at altitudes up to 800 m (DEC 2005j).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: loss of habitat from clearing for urban expansion; risk of extinction because populations are small and distribution is highly restricted; timber harvesting activities; fire, as hot fires will kill the plants; and invasion of habitat by weeds (DEC 2005j).

Key Threatening Processes listed on the TSC Act that are relevant to the proposed upgrade and may impact on potential habitat for *Corokia whiteana* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Corokia whiteana.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Corokia whiteana*.
- Invasion of native plant communities by exotic perennial grasses – it is

possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, as a precaution, weed control works should be detailed in a Vegetation Management Plan.

To date, no Recovery Plan has been prepared for *Corokia whiteana.* The DECC (DEC 2005j) has identified a number of actions to help the recovery of this species. Those that are relevant to the proposed upgrade are detailed below:

- Protect rainforest areas from fire – the proposed upgrade is not likely to increase fire frequency in the local area.
- Control weeds in and around rainforest habitat – the Vegetation Management Plan will detail weed control works.
- Protect remaining habitat from clearing and timber harvesting – the proposed upgrade would result in the removal of potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species, as known habitat for the species will not be impacted.

Local and regional abundance

There are 80 known records of the species in NSW (DEC 2007), most of which occur in the Ballina LGA, three in the north-west of the state in the Tenterfield/Glen Innes to the west of the study area around Lismore.

One known record of this species occurs within a 10 km of the study area and is located approximately 7 km to the north of the study area (Figure 3). Four plants have previously been recorded at this location (DEC 2007).

Locations relative to limits of distribution

Corokia whiteana occurs only in north-east NSW and has a highly restricted distribution. Three distinct populations are known: one in the Nightcap Range, one in the Tweed Valley, and the other close to the coast near Brunswick Heads. The study area is near the known limit of distribution for this species.

Habitat (within study area**)**

This species has previously been recorded approximately 7 km to the north of the study area within a small isolated patch of Lowland Rainforest. There are no known records of the species within patches of vegetation that are present within the study area .

Potential habitat for this species within the study area includes Lowland Rainforest. This habitat occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Corokia whiteana was not detected during field surveys within the study area. Approximately 2.0 ha of potential habitat would be removed (from approximately 776 ha within the Locality (NPWS 1997b)). This represents 0.3 % of potential habitat within the Locality (10 km radius of the study area).

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank and disrupting recruitment within the potential habitat in the study area. However, this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat for this species within the local area would be directly impacted by the proposed upgrade, the fact that the species was not recorded during field surveys, and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species, it is considered unlikely that a viable local population of *Corokia whiteana* would be

placed at risk of extinction by the proposed upgrade.

Davidsonia jerseyana

Description

Davidsonia jerseyana is a small tree that grows to 10 m tall, either with a single unbranched stem or several stems arising from the base. The species has large, hairy leaves that are bunched towards the top of the trunk (DEC 2005l). The flowers are small and pinkish flowers and are borne directly from the main stem in long, loose clusters (DEC 2005l).

Conservation status

Davidsonia jerseyana is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2ECi, indicating:

2 = A geographic range of <100 km

E = Endangered species

C = Reserved, with a least one population in a national park

i = inadequately reserved (<1000 plants)

Many Davidson's Plum records occur on land that does not have zoning secure for conservation or consistent with nature conservation objectives. There are only two confirmed sub-populations of this species known from within conservation reserves (Brunswick Heads and Billinudgel Nature Reserves). An unconfirmed record exists from Couchy Creek Nature Reserve (DEC 2004c).

Habitat requirements

Potential habitat for *Davidsonia jerseyana* exists in Lowland subtropical rainforest and wet eucalypt forest at low altitudes (below 300m) (DEC 2005l). Several sub-populations of *Davidsonia jerseyana* are known from areas of regrowth rainforest with a high percentage of Camphor Laurel, *Lantana camara* (Lantana) and other exotic weeds (DEC 2004c).

Davidsonia jerseyana has been recorded at altitudes up to 300 m, however most records have been made at altitudes below 100 m (DEC 2004c). Slope and aspect vary, with the majority of known sub-populations occurring on south and east-facing slopes, with only a few individuals recorded from north-facing slopes (DEC 2004c). Plants are generally located in clusters around sheltered lower hill slopes

(DEC 2004c).

Soils which the species is known to be associated with include red and yellow soils of poor structure, over Silurian greywacke, slate, phyllite and quartzite, with one unconfirmed record (at Tomewin) on krasnozem soils and two unconfirmed records are on podzols adjacent to krasnozems (DEC 2004c).

The following is known about the breeding cycle of *Davidsonia jerseyana* (DEC 2004c):

- The species frequently occurs in clumps with a number of stems separated at ground level, which assumed to be due to a combination of root suckering plus seedlings developing from seeds dropped below the parent.
- Trees in cultivation have been recorded as producing viable fruit after five years.
- The species is known to bear flowers and fruits when very small, especially when stressed.
- Little information is available on the pollination of *Davidsonia jerseyana*. The size and form of the flower suggest that vectors are likely to be small insects. Ants (species uncertain) were the only visitors to the flowers during diurnal and nocturnal observation of the flowers, however they are unlikely to act as pollinators for this species.
- Fruiting times apparently vary between subpopulations. The age at which individual plants reach their peak fruiting is unknown.
- Little is known of seed dispersal in *Davidsonia jerseyana*, flying foxes have been observed eating unripe Davidson's Plum fruit, while distinct bird bill imprints and rodent teeth marks on ripe fruit have also been observed. King Parrots have been observed eating the seeds.
- The species is easily grown from seed, and is readily established. The seeds have a very high viability rate, at around 80 %. There is no dormancy period in *Davidsonia jerseyana* seeds and there is no evidence of soil storage of seeds.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Davidsonia jerseyana* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Davidsonia jerseyana.*

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Davidsonia jerseyana*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, as a precaution, weed control works should be detailed in a Vegetation Management Plan.

A Recovery Plan has been prepared for *Davidsonia jerseyana* (DEC 2004c), and lists six objectives to assist in the recovery of the species. Those relevant to the proposed upgrade include:

- Manage and protect *Davidsonia jerseyana* and associated habitat from threatening processes – potential habitat for the species will be cleared for the proposed upgrade.

The Recovery Plan lists the following threats to *Davidsonia jerseyana* (DEC 2004c):

- Habitat alteration and fragmentation,

- Loss of genetic variation,

- Genetic pollution, and

- Collection for the bush food and nursery industry.

Roads, and specifically Pacific Highway upgrades, are listed in the Recovery Plan as a mechanism that could increase the threat of fragmentation to the habitat of *Davidsonia jerseyana.* The proposed upgrade would not increase fragmentation of habitat for *Davidsonia jerseyana,* as potential habitat for *Davidsonia jerseyana* that would be directly impacted as part of the proposed upgrade consists of approximately 6 small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species, as

no known records of the species would be impacted.

Local and regional abundance

The species has been documented as occurring at a total of 118 point locations, which can be roughly grouped into 24 naturally occurring sub-populations. The results of genetics research on the species may cause these groupings to be redefined (DEC 2004c). Most of the known records in NSW occur in the Byron and Tweed areas (DEC 2007).

Most sub-populations comprise small numbers of mature individuals with a few suckers or seedlings. Two of the largest known sub-populations surveyed are unusual in that they exhibit mixed size class distributions indicative of continuous regeneration. These sites occur in habitats that, though of limited area, are in reasonably good condition. In contrast, another sub-population consists of more than 20 mature individuals that occur as scattered paddock trees with little or no regeneration (DEC 2004c).

Eight known records of this species occur within 10 km of the study area. The closest of which occurs approximately 1 km to the east of the subject site (Figure 3). Two of the records have count information, one supporting 15 plants and the other supporting three plants (DEC 2007).

Locations relative to limits of distribution

Davidsonia jerseyana is restricted to the Brunswick and Tweed River catchments of the north coast of NSW. The southern-most confirmed record of the species was located near Mullumbimby (DEC 2004c), though recent records suggest the species occurs as far south as Wardell (DEC 2005l). Records extend only a short distance inland on the Brunswick River (DEC 2004c). The northern-most and western-most confirmed record is at Chillingham. There is an unconfirmed record further north near the border gate at Tomewin (DEC 2004c). There are no confirmed records for southern Queensland (DEC 2004c). The study area is near the known limit of distribution for this species.

Habitat (within study area**)**

This species has previously been recorded approximately 1 km to the east of the subject site. There are no known records of the species within the patches of vegetation that are present within the study area.

Habitat for this species within the study area includes Lowland Rainforest and patches of Camphor Laurel. This habitat occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

No known populations of *Davidsonia jerseyana* would be impacted by the proposed upgrade, with the closest record occurring approximately 1 km to the east of the proposed upgrade. Potential habitat for *Davidsonia jerseyana* occurs in Lowland Rainforest and patches of Camphor Laurel in the study area. The removal of 7.7 ha of vegetation that is potential habitat for *Davidsonia jerseyana*, with a further 20.8 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species given that no known individuals of the species would be impacted and that there is approximately 776 ha of Rainforest (NPWS 1997b) and a large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and modification of habitat in the study area, however this is unlikely as the species was not recorded in the study area.

Potential habitat for *Davidsonia jerseyana* that would be directly impacted as part of the proposed upgrade consists of approximately six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Davidsonia jerseyana* or any potential habitat for the species.

Given that the species was not recorded during field surveys, the proposed upgrade is not likely to fragment an existing population and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species. It is considered unlikely that a viable local population of *Davidsonia jerseyana* would be placed at risk of extinction by the proposed upgrade.

Davidsonia johnsonii

Description

Davidsonia johnsonii is a bushy, well-branched tree 5 – 12 m tall, with a dense crown (DEC 2005•). The smooth, glossy leaves are large and divided into 7 - 9

toothed leaflets (DEC 2005•). Small, pinkish flowers are borne in loose clusters (DEC 2005•).

Conservation status

Davidsonia johnsonii is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2ECi, indicating:

2 = A geographic range of <100 km

E =Endangered species

C = Reserved, with a least one population in a national park

i = Less than 1000 plants are known to occur within a conservation reserve(s)

Queensland sites of *Davidsonia johnsonii* occur within private land (DEC 2004f). NSW sites of the species occur within (DEC 2004f):

- Snows Gully Nature Reserve and Goonengerry Nature Reserve, which are managed by the DECC;
- Pocket Road Reserve, which is managed by Byron Shire Council (plants extend onto private property);
- Hogans Scrub within a road reserve, managed by the Tweed Shire Council (most plants at this location occur on private land); and
- Private land.

Many sites occur on land that does not have zoning that is considered secure or consistent with nature conservation objectives (DEC 2004f). The species is not likely to be adequately represented in conservation reserves in the region.

Habitat requirements

Davidsonia johnsonii is found mainly in wet sclerophyll forests and subtropical rainforest (complex notophyll vine forest). All lowland rainforest communities, wet sclerophyll forests and regrowth on land which formerly supported these communities, within and surrounding the range of the species, should be regarded as potential habitat (DEC 2004c).

Records of individuals have also been made from land that was formerly cleared. Plants still persist in these areas as isolated clumps in paddocks or in regrowth

dominated by Lantana (*Lantana camara*) and other weed species (DEC 2004f).

Davidsonia johnsonii is known to occur from an altitudinal range of 30–270 m. The species is known to occur on landforms that include moderate to gentle slopes, creek flats and gullies. Aspect is most commonly south-west to south-east, although at least one known site is in a north-facing location. Soils are derived from a variety of parent materials including shallow, clay-loam podzol, with surface rocks, weathered from metasediments of the Neranleigh-Fernvale complex and the basalts and rhyolites of the Lamington volcanics, with common occurrences of the species at the boundaries of basalt and rhyolite (DEC 2004f).

The following is known about the breeding cycle of *Davidsonia johnsonii* (DEC 2004f):

- Reproduces vegetatively by way of root suckers. Suckers are particularly prolific where soil has been disturbed or plants slashed. This mode of reproduction has enabled patches of the species to survive even when surrounding vegetation has been completely cleared. Some patches appear to have regrown following the abandonment of pasture or banana plantations.

- Flowering at some sites has been detected as early as September, but at other sites, flowering did not commence until November.

- Mode of pollination of *Davidsonia johnsonii* flowers is not understood. The size and form of the flower suggest that the vectors are likely to be small insects. Bees (including native bees), beetles and ants have been observed visiting the flowers.

- Fruiting occurs between December and March, but occasional fruit occurs as late as June.

- There have only been two instances of seed being found within the fruit of this species. Reasons for the low incidence of seed production may include isolation from compatible plants, lack of production of pollen, no transfer of pollen from anther to stigma, non viable pollen, self-incompatibility mechanisms, and early abortion of the developing embryo.

- Limited observation of ex-situ individuals suggests that the species is moderately slow growing and that first fruiting by individuals occurs approximately ten years after propagation, at a height of 2–3 m. The age at which the production of root suckers can commence, and the extent to which soil disturbance and/or physical root damage is necessary, is unknown.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes listed on the TSC Act that are relevant to the proposed

upgrade and may impact on potential habitat for *Davidsonia johnsonii* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Davidsonia johnsonii.*

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Davidsonia johnsonii*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Many known records of *Davidsonia johnsonii* are from areas of regrowth vegetation, or on the edges of forests, situations in which it is particularly prone to exotic weed competition (DEC 2004f). Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- Exotic vines and scramblers – *Davidsonia johnsonii* is specifically listed as a species that may be impacted by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects. However, weed control works should be detailed in a Vegetation Management Plan.

- *Lantana camara* - *Davidsonia johnsonii* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, weed control works should be detailed in a Vegetation Management Plan.

A Draft Recovery Plan has been prepared for *Davidsonia johnsonii* (DEC 2004f), and lists 6 objectives to assist in the recovery of the species. Those relevant to the proposed upgrade include:

- To manage and protect the *Davidsonia johnsonii* population and associated habitat – the proposed upgrade would result in clearing of potential habitat for the species.

The Recovery Plan lists the following threats to *Davidsonia johnsonii* (DEC 2004f):

- Habitat destruction and fragmentation: the proposed upgrade would result in

the removal of potential habitat for *Davidsonia johnsonii*. The proposed upgrade would not result in the fragmentation of any areas of habitat, as the patches of vegetation impacted exist as small isolated patches in a predominantly cleared landscape, with only the edges of each patch impacted.

- Habitat degradation, including weed infestation: the patches of potential habitat impacted the proposed upgrade were considered to be in poor condition due to existing weed infestation. The proposed upgrade may, however, result in the increase in weed infestation in the impacted patches. A number of recommendations have been made to reduce the threat of increase weed invasion, such as bush regeneration and using local native species in landscaping.

- Lack of genetic variation: the proposed upgrade would not further reduce the genetic variation of *Davidsonia johnsonii*, as no known populations would be impacted by the proposed upgrade.

- Road construction and maintenance: the proposed upgrade does not impact on any known populations of *Davidsonia johnsonii*, but will impact directly on approximately 2.0 ha of potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known habitat would be impacted and the threats will be generally managed through mitigation.

Local and regional abundance

Davidsonia johnsonii is known from 28 sites (DEC 2004c). In March 1999, the total known population of *Davidsonia johnsonii* was estimated at 2000 stems. This estimate may have a considerable error margin since a number of sites have not been surveyed recently, and plants have not been counted using a consistent methodology. The reproductive biology of *Davidsonia johnsonii* (ie. primarily vegetative) suggests that the number of genetically distinct individuals may be low. It is possible that each of the specimens recorded from known sites are clonal (DEC 2004f).

According to the Atlas of NSW Wildlife online database (DEC 2007), there are 94 known locations of the species in NSW, all of which occur in the Ballina, Byron Bay and Tweed Heads area.

There are 14 known records of this species within a 10 km radius of the study area, 11 of which exist to the east of the study areain Broken Head Nature Reserve. There is also one record to the west of Broken Head Nature Reserve along a creekline which supports an estimated 1000 plants (Figure 3). The closest known population of the species occurs approximately 350 m to the south of the subject

site.

Locations relative to limits of distribution

The distribution of *Davidsonia johnsonii* is restricted from the Tallebudgera and Numinbah Valleys in Queensland to approximately 70 km south at Tintenbar, near Ballina. Most locations are close to the coast, but two isolated sites are 25–30 km inland at Nimbin and Terania Creek (DEC 2004f). Five locations are known in the Tweed Valley, four are in the Brunswick Valley, and the remainder are in the catchment of the Richmond River, ranging from the upper reaches of the Goolmangar, Terania, Wilsons and Coopers Creeks to the coastal plains (DEC 2004c). The study area is at the southern limit of distribution of the species.

Habitat (within study area**)**

Davidsonia johnsonii was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest. This habitat occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Davidsonia johnsonii*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat that would be directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of *Davidsonia johnsonii* is likely to be disrupted should any of the following occur (DEC 2004c):

- Physical destruction of plants – the proposed upgrade would not result in the

removal of any individuals of *Davidsonia johnsonii*

- Fruit collection – the proposed upgrade would not require collection of any fruit from *Davidsonia johnsonii*
- Habitat modification – the proposed upgrade would result in the removal of approximately 2.0 ha of habitat for *Davidsonia johnsonii,* with potential modifications to an additional 3.6 ha of potential habitat.
- Threatening processes - as described above, the main threat to the species is clearing of habitat that would be increased as a result of this proposed upgrade.

Davidsonia johnsonii is known from 28 sites, which are isolated from each other by an apparent inability to set seed, and by unsuitable habitat and land-clearing (DEC 2004c). The proposed upgrade would not lead to further isolation of *Davidsonia johnsonii* populations in the local area, as the proposed upgrade does not result in fragmentation of a currently interconnected population of the species.

Given that only 0.3 % of potential habitat for this species would be directly impacted within the local area by the proposed upgrade, and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Davidsonia johnsonii* would be placed at risk of extinction by the proposed upgrade.

Desmodium acanthocladum

Description

Desmodium acanthocladum is a sprawling shrub 1 – 2 m in height and often more than 2 m wide. The branches are rather rigid, though they commonly arch over other vegetation. The leaves are alternate up the stem and are divided into three leaflets, the middle one longer than the other two and up to 2.5 cm in length. The branchlets are scattered with sharp spines. Pink or purple pea flowers are produced in summer and are followed by a sticky seed pod about 5 cm long (DEC 2005¢).

Conservation status

Desmodium acanthocladum is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2VC-, indicating:

2 = A geographic range of <100 km

V =Vulnerable species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

According to the Atlas of NSW Wildlife online database (DEC 2007): records of the species exist within Mount Warning National Park (though this is a very old record from 1898) and Andrew Johnston Big Scrub Nature Reserve. This species is not likely to be adequately represented in conservation reserves.

Habitat requirements

Desmodium acanthocladum is known to occur in dry rainforest and fringes of riverine subtropical rainforest, on basalt-derived soils at low elevations (DEC 2007).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC (DEC 2005¢) lists the following threats to *Desmodium acanthocladum*:

- Clearing and fragmentation of habitat for agriculture or development;
- Damage to plants and habitat by roadworks;
- Browsing and trampling by stock; and,
- Weed infestation, particularly by introduced vines such as Asparagus, and Lantana.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Desmodium acanthocladum* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Desmodium acanthocladum.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Desmodium acanthocladum.*
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation

Management Plan.

- Exotic vines and Scramblers –*Desmodium acanthocladum* is specifically listed as a species that may be impacted by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara* - *Desmodium acanthocladum* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. Weed control works should be detailed in the Vegetation Management Plan.

To date, no Recovery Plan has been written for *Desmodium acanthocladum.* The DECC (DEC 2005¢) lists recovery actions for species. Those relevant to the project are listed below:

- Protect known populations during roadworks – there are no known populations of the species within the subject site;

- Control weeds – weed control works should be specified in the Vegetation Management Plan; and

- Protect known and potential habitat from clearing or development – no known habitat would be impacted by the proposed upgrade. Approximately 2.0 ha of potential habitat would be directly impacted by the Proposed Developement.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known habitat for the species would be impacted.

Local and regional abundance

According to the Atlas of NSW Wildlife online database (DEC 2007), there are 193 known locations of the species in northern NSW, the majority of which occur in the west of Byron Bay and Lismore area. There is also a record of the species as far south as Grafton (NSW Government 2007).

There are 16 known records of this species within a 10 km radius of the study area, occurring approximately 5 km to the west of the subject site. Three of these records have count information, supporting between 5 and 10 plants (DEC 2007). The

species was not recorded in the study area.

Locations relative to limits of distribution

Desmodium acanthocladum occurs only in north-east NSW. It is found in the Lismore area, and there are also records from near Grafton, Coraki, Casino and the Mount Warning area (DEC 2005¢). The study area is near the southern limit of distribution for the species.

Habitat (within study area)

Desmodium acanthocladum was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest, which occurs as small, fragmented stands. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Desmodium acanthocladum*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank and disrupting recruitment within the potential habitat in the study area. However, this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted

is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat for this species within the Locality would be directly impacted and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Desmodium acanthocladum* would be placed at risk of extinction by the proposed upgrade.

Diploglottis campbellii

Description

Diploglottis campbellii is a large tree to 30 m tall (DEC 2005"). Small clusters of greenish-white flowers are borne amongst the leaves and the fruits are creamy-brown and in crowded clusters about 10 cm long (DEC 2005").

Conservation status

Diploglottis campbellii is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2E, indicating:

2 = A geographic range of <100 km

E =Endangered species

Many *Diploglottis campbellii* sites occur on land that does not have zoning considered secure or consistent with nature conservation objectives (DEC 2004a). One known record of the site occur within a Conservation Reserve in Byron Bay, however the majority of known records occurs within road reserves and rural land (DEC 2004a). This species is not likely to be adequately represented in conservation reserves.

Habitat requirements

The forest types in which *Diploglottis campbellii* occurs vary from lowland subtropical rainforest to drier subtropical rainforest with a Brush Box overstorey on basalt-derived soils and also on poorer soils such as those derived from quartz monzonite (DEC 2005"). Preferred climate for the species is warm subtropical rainforest areas, with mild winters and marked summer and autumn rainfall (DEC 2004a).

The following is known about the breeding cycle of *Diploglottis campbellii* (DEC 2004a):

- Flowering time is from November to March. The method of pollination is

unknown.

- Ripe fruit are generally present from January to early April.
- Seed dispersal mechanisms are not fully understood, yet flooding and down-slope dispersal may play a role in dispersal of seed. Fruit type is suitable for avian dispersal, but ripe fruit has been observed under trees showing no signs of being chewed.
- Viability testing showed that seed viability varies from 43% to 100%, however natural germination rates have been shown to be lower than this.
- The species occurs as isolated sites throughout most of its range, each site consisting of less than 20 adults, with only nine sites actively recruiting seedlings and juveniles.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Diploglottis campbellii* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Diploglottis campbellii.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Diploglottis campbellii*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Exotic vines and Scramblers – *Diploglottis campbellii* is specifically listed as a species threatened by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara* - *Diploglottis campbellii* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed

upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. Weed control works should be detailed in the Vegetation Management Plan.

A Recovery Plan for *Diploglottis campbellii* has been prepared (DEC 2004a). The Recovery Plan lists seven recovery objectives and a number of actions required to reach these objectives. Those relevant to the proposed upgrade include:

- To manage and protect the *Diploglottis campbellii* population and associated habitat – the proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for the species.

The Recovery Plan makes specific mention of the threat of road development, with one of the actions of the Recovery Plan being (DEC 2004a):

'Road development and widening activities and roadside maintenance in areas identified as having *Diploglottis campbellii* present will be restricted to actions that avoid damage to the species or its habitat'.

The proposed upgrade is not likely to interfere with the recovery of *Diploglottis campbellii*, as the proposed upgrade results in the removal of two known records, both of which are planted. There is an additional record of the species which occurs within the indirect impact area. This plant will need to be protected during construction works.

Local and regional abundance

The species now only occurs as small clusters or as individual paddock trees. The species also occurs in small numbers on the steep slopes of the plateau edges and adjoining floodplains where agricultural development has been less intense (DEC 2004a).

There are 25 sites at which *Diploglottis campbellii* is known to occur, with the total known population estimated at 106 mature trees plus immature trees, saplings and seedlings (DEC 2004a). In addition to these naturally occurring sub-populations, a large number of individuals have been propagated and planted in *ex-situ* locations, with 6,000 trees distributed since 1993 (DEC 2004a).

According to the Atlas of NSW Wildlife online database (DEC 2007), there are 144 known locations of the species in northern NSW, the majority of which occur northwest of the study area near Tweed. There are also a few records of the species northwest of Ballina. The Bionet Database (NSW Government 2007) shows records of the species also occurring as far south as Coffs Harbour and Sydney.

Twenty nine records of the species occur within a 10 km radius of the study area.

One of these records contains count information, supporting one plant (DEC 2007).

Locations relative to limits of distribution

Diploglottis campbellii has been recorded from coastal lowlands between the Richmond River on the Far North Coast of NSW to Mudgeeraba Creek on the Gold Coast hinterland, Queensland. The current distribution of *Diploglottis campbellii* does not reflect its historical distribution within its range (DEC 2004a). The study area is near the southern limit of the current distribution of the species.

Habitat (within study area)

Diploglottis campbellii has been recorded within the study area (Figure 3), with:

- Two records in a patch of replanted Lowland Rainforest (Patch 10, Figure 2), to the immediate west of the Pacific Highway at Newrybar (Yarrenbool Place). Collectively, these records represent two planted individuals and occur in the directly impacted area; and,
- One record immediately south-east of Patch 12 (Figure 2). This record represents one individual and is within the indirectly impacted area.

Within the study area, potential habitat for this species is considered to be within Lowland Rainforest and patches of Camphor Laurel. This vegetation occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004a), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Two known records of *Diploglottis campbellii* would be impacted by the proposed upgrade, both planted individuals. In addition, one record of the species occurs to the immediate west of the Subject Site and will need to be protected from impacts during and after construction. This plant occurs on the edge of a small patch of Lowland Rainforest.

Potential habitat for *Diploglottis campbellii* occurs in patches of Lowland Rainforest and Camphor Laurel in the study area. The removal of 7.7 ha of vegetation that is potential habitat for *Diploglottis campbellii*, with a further 20.8 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species given that no known individuals of the species would be impacted and that there is approximately 776 ha of Rainforest (NPWS 1997b) and a

large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through displacement of individuals, disruption of the breeding cycle, disturbance to the soil seed bank and disrupting recruitment within the habitat present in the study area. These impacts to the lifecycle of the species are likely to be minor given that the two impacted individuals are planted.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. The habitat to be impacted by the proposed upgrade is not likely to be important to the long term survival of the species in the local area given the small size of patches and their poor condition.

Provided the individual plant within the indirectly impacted area is adequately protected during construction activities, only two planted specimens will be directly impacted. The overall impact on the species is likely to be minor.

Drynaria rigidula

Description

Drynaria rigidula grows in a large clump, and has two quite different frond types. The lower 'nest' fronds are short, papery, brown and shaped like an oak-leaf. The green, more erect fronds may be up to 2 m in length and are segmented into many blunt-toothed leaflets on short stalks. Round clumps of spores occur in two rows on the backs of the leaflets, making a bulge on the front of the leaflet. The green fronds may be lost during dry periods (DEC 2005p).

Conservation status

Drynaria rigidula is listed as Endangered on the TSC Act. The species was presumed extinct in New South Wales and has been recently rediscovered (NSW Scientific Committee 1998a).

The species was not known from any conservation reserves in 1998 (NSW Scientific Committee 1998a), however the species was more recently recorded in Mooball National Park, near Murwillumbah (DEC 2007) . The species is not

considered to be adequately conserved in the region.

Habitat requirements

Drynaria rigidula is a fern that grows on rocks, as an epiphyte or on the ground from the Clarence River in northern coastal N.S.W (NSW Scientific Committee 1998a, DEC 2005h). The species is usually found in rainforest but also in moist eucalypt and Swamp Oak forest (DEC 2005p).

Key Threatening Processes, Recovery and Threat Abatement Plans

The species is threatened by loss of habitat and the risk of extinction is high due to very low population numbers (NSW Scientific Committee 1998a). Addition threats are considered to be (DEC 2005p):

- Loss of habitat through clearing for agriculture and development.
- Frequent fires, as the plant has limited tolerance for fire.
- Browsing and trampling by domestic stock.
- Invasion of weeds and habitat degradation, which limits opportunities for establishment of young plants.
- Removal of forest understorey, resulting in loss of habitat.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Drynaria rigidula* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Drynaria rigidula.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Drynaria rigidula*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara - Drynaria rigidula* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the

patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, a Recovery Plan for *Drynaria rigidula* has not been prepared (DEC 2005h). DECC (DEC 2005p) recommend a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Protect areas of rainforest, moist eucalypt and swamp forest from fire – the proposed upgrade is not likely to alter the frequency of fire in the local area.
- Control weeds in rainforest, moist eucalypt and swamp forests – weed control works should be specified in the Vegetation Management Plan.
- Protect known and potential habitat from clearing and development – potential habitat for the species will be cleared for the proposed upgrade.

No individuals of *Drynaria rigidula* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

The species is common in Queensland, however, as of 1998 the species was only known from three locations in NSW (NSW Scientific Committee 1998a), though more recent recordings of the species indicate seven known locations (DEC 2007). Only one plant is known from each of the known locations in N.S.W (NSW Scientific Committee 1998a).

Three records of the species occur within a 10 km radius of the study area.

Locations relative to limits of distribution

The species occurs widely in eastern Queensland as well as islands of the Pacific and parts of South-East Asia. In NSW it is only found north of the Clarence River, in a few locations at Maclean, Bogangar, Byron Bay, Mullumbimby, in the Tweed Valley and at Woodenbong (DEC 2005p).

The Atlas of NSW Wildlife (DEC 2007) shows a location of the species to the south of the study area at Woodburn. Records of the species also occur to the north of the study area in the Tweed area (DEC 2007). The study area is not at the limit of distribution for the species.

Habitat (within study area)

Drynaria rigidula was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest. This habitat occurs as small, fragmented patches, which were

considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2005p), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Drynaria rigidula*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Drynaria rigidula* would be placed at risk of extinction by the proposed upgrade.

Elaeocarpus williamsianus

Description

Elaeocarpus williamsianus is a small tree up to 15 m tall, with creamy brown bark. The leaves measure 9 – 18 cm long and 2 – 5 cm wide, and are glossy green above and covered in rusty hairs below. The leaves have rounded tips, and may have a few shallow teeth and a joint where the leaf-blade meets the leaf-stalk. Small

clusters of greenish-white flowers are borne amongst the leaves. The fruits are blue, shiny and round, and about 2 – 3 cm in diameter (DEC 2005|).

Conservation status

Elaeocarpus williamsianus is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2ECi, indicating:

2 = A geographic range of <100 km

E = Endangered species

C = Reserved, with a least one population in a national park

i = inadequately reserved (<1000 plants)

Two sites supporting the species occur in conservation reserves: Mooball National Park and Inner Pocket Nature Reserve (DEC 2004g).

Habitat requirements

Elaeocarpus williamsianus occurs along the coastal range within notophyll vine rainforests and wet sclerophyll ecotones on metasediment-derived soils (DEC 2004g). The species is also known to occur in subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing (DEC 2005|). The species is typically found on steep and eroding slopes at low altitude in gullies, toe slopes, steep drops adjacent to creeks and the headwater areas of creeks (DEC 2004g).

Common dominant canopy species include *Cinnamomum camphoraa*, *Lophostemon confertus* and *Eucalyptus grandis*. Other dominant species include *Lantana camara* and *Planchonella australis* (DEC 2004g).

The climate over the range of *Elaeocarpus williamsianus* is subtropical with a well-defined summer and autumn wet season (DEC 2004g). The driest months are August and September and rainfall is generally in excess of 2000 mm per year (DEC 2004g).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include: habitat clearing and fragmentation, habitat disturbance, weed invasion, introduced pathogens, loss of genetic diversity and genetic isolation and inappropriate fire regimes (DEC 2004g).

Key Threatening Processes listed on the TSC Act that are relevant to the proposed upgrade and may impact on potential habitat for *Elaeocarpus williamsianus*

include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Elaeocarpus williamsianus*.

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Elaeocarpus williamsianus*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in a Vegetation Management Plan.

- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, as a precaution, weed control works should be detailed in a Vegetation Management Plan.

A Recovery Plan has been prepared for *Elaeocarpus williamsianus* (DEC 2004g). A number of recovery objectives have been identified in the Recovery Plan (DEC 2004g). None of the listed objectives are relevant to the proposed upgrade as the species was not recorded in the study area.

DECC have listed a number of recovery actions to assist in the recovery of the species. Those relevant to the proposed upgrade include (DEC 2005|):

- Avoid fire around the edges of rainforest patches – the proposed upgrade is not likely to alter the fire frequency within the local area.

- Identify populations along roadsides and protect them during roadworks – the species was not recorded in the study area

- Control introduced weeds in rainforest areas – weed control works should be detailed in a Vegetation Management Plan.

- Protect areas of rainforest habitat from clearing and fragmentation – potential habitat for *Elaeocarpus williamsianus* will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of the species, as known habitat for the species will not be impacted.

Local and regional abundance

Elaeocarpus williamsianus is currently known from nine populations in north-eastern NSW extending from the Tweed Valley, south to the Byron Bay area (DEC 2004g).

Two known records of this species occur within 10 km of the study area. The closest of which occurs approximately 4 km to the east of the subject site within a small isolated patch of Lowland Rainforest (Figure 3).

Locations relative to limits of distribution

The known range for the species covers an area of approximately 50 km north-south by 30 km east-west and, extending from the Tweed Valley, south to the Byron Bay area (DEC 2004g). The study area is near the known limit of distribution for this species.

Habitat (within study area)

This species has previously been recorded approximately 4 km to the east of the subject site. There are no known records of the species within the patches of vegetation present in the study area.

Habitat for this species within the study area includes Lowland Rainforest and patches of Camphor Laurel. This habitat occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004g), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Elaeocarpus williamsianus was not detected during field surveys within the study area. Potential habitat for *Elaeocarpus williamsianus* occurs in Lowland Rainforest and patches of Camphor Laurel in the study area. The removal of 7.7 ha of vegetation that is potential habitat for *Elaeocarpus williamsianus*, with a further 20.8 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species given that no known individuals of the species would be impacted and that there is approximately 776 ha of Rainforest (NPWS 1997b) and a large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately

50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However, this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only a small area of potential habitat for this species within the local area would be directly impacted by the proposed upgrade, the fact that the species was not recorded during field surveys and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species, it is considered unlikely that a viable local population of *Elaeocarpus williamsianus* would be placed at risk of extinction by the proposed upgrade.

Endiandra floydii

Description

Endiandra floydii is a small tree to 15 m tall, often with coppice shoots at the base, and with dark green shiny adult leaves, and pinkish-brown new leaves (DEC 2005k). The small green to cream flowers are held in small clusters back within the leaves and the fruits are red to purplish-black when ripe (DEC 2005k).

Conservation status

Endiandra floydii is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2VC-, indicating:

2 = A geographic range of <100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

- = Adequacy of reservation not known

Endiandra floydii is known from the following conservation reserves (DEC 2004h): Couchy Creek Nature Reserve, Mooball National Park, Marshalls Creek Nature

Reserve and Brunswick Heads Nature Reserve. The species is also known to occur in reserves at Wongawallen made up of freehold land and roadside reserves managed by Tweed Shire Council (DEC 2004h).

Habitat requirements

Endiandra floydii occurs in warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest (DEC 2005k).

Endiandra floydii occurs in subtropical (including littoral) rainforest or wet sclerophyll forest, often with *Lophostemon confertus* in the canopy and occasionally with *Araucaria cunninghamii* emergents (DEC 2004h). Disturbed and regrowth sites may include *Cinnamomum camphoraa* and *Lantana camara* as weed components (DEC 2004h). Most locations are on soils derived from paleozoic metamorphics, sometimes with basalt nearby. A small number of sites are on alluvium or sand (DEC 2004h).

Sheltered locations are apparently preferred, and landforms including ridgelines, slopes, gullies and creek flats have been documented. The altitude varies between close to sea level up to 430 m above sea level (DEC 2004h).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Endiandra floydii* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Endiandra floydii.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Endiandra floydii*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in a Vegetation Management Plan.
- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, as a precaution, weed control works should be detailed in a Vegetation Management Plan. As a precaution, weed control works should

be detailed in a Vegetation Management Plan.

Threats to the species include (DEC 2004h): low numbers; habitat clearing and fragmentation; development; weeds; grazing; roadside damage; poor regeneration; genetic problems; collections of propagation material; and, lack of information about threats.

A Draft Recovery Plan for *Endiandra floydii* has been prepared (DEC 2004h) and lists 9 recovery objectives. Those relevant to the proposed upgrade include:

- To manage and protect *Endiandra floydii* and associated habitat from threatening processes – potential habitat for the species would be impacted by the proposed upgrade.
- Fire planning and management – the proposed upgrade is not likely to alter the fire frequency within the local area.

The proposed upgrade is not likely to interfere with the recovery of the species, as known habitat for the species will not be impacted.

Local and regional abundance

Regional occurrences of *Endiandra floydii* include (DEC 2004h):

- two large populations in the ranges to the north of Murwillumbah, where numerous other smaller occurrences are also found;
- at least 50 individuals from the Urliup Road area;
- 40–50 trees from Crystal Creek; and,
- nearly 80 individuals at Mooball National Park.

In Queensland, the largest occurrences of the species are in the Wongawallen area, where a total of about 50 individuals have been recorded with others likely to be present in unsurveyed adjacent habitat (DEC 2004h).

All known occurrences are within 30 km of the coast. It is not possible to estimate the total number of individuals of *Endiandra floydii* as counts or estimates have not been made for a large number of sites, but at least 400 individuals, including seedlings, saplings and mature trees, are known (DEC 2004h).

Three known records of this species occur within 10 km of the study area. The closest of which occurs approximately 5 km to the east of the subject site (Figure 3).

Locations relative to limits of distribution

Endiandra floydii is known from Pimpama, just north of the Queensland Gold Coast, south to Byron Hills and, 6 km south of Cape Byron, NSW (DEC 2004h). The study area is near the known limit of distribution for this species.

Habitat (within study area)

There are no known records of the species within the patches of vegetation within the study area. Habitat for this species within the study area includes Lowland Rainforest and patches of Camphor Laurel. This habitat occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004h), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Endiandra floydii was not detected during field surveys within the study area. Potential habitat for *Endiandra floydii* occurs in Lowland Rainforest and Camphor Laurel in the study area. The removal of 7.7 ha of vegetation that is potential habitat for *Elaeocarpus williamsianus*, with a further 20.8 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species given that no known individuals of the species would be impacted and that there is approximately 776 ha of Rainforest (NPWS 1997b) and a large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only a small area of potential habitat for this species within the local area would be directly impacted by the proposed upgrade, the fact that the species was not recorded during field surveys and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species, it is considered unlikely that a viable local population of *Endiandra floydii* would be placed at risk of extinction by the proposed upgrade.

Endiandra hayesii

Description

Endiandra hayesii is a small crooked tree, but it can grow to 35 m tall. It has grey to grey-brown bark, which is smooth or slightly scaly. The dull, hairy leaves are egg-shaped and measure 6 – 12 cm long and 3 – 6 cm wide. The leaves have a closely veined appearance. Flowers are small and white to pale green, and are held in small clusters. The fleshy fruits are egg-shaped, 2.5 – 3 cm long, and purplish-black when ripe (DEC 2005t).

Conservation status

Endiandra hayesii is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VC-, indicating:

2 = A geographic range of >100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

- = Adequacy of reservation not known

Endiandra hayesii is known from the following conservation reserves (DEC 2004d): Nature Reserves of Billinudgel, Broken Head, Brunswick Heads, Inner Pocket, Limpinwood, Numinbah and Snows Gully; National Parks of Border Ranges, Goonengerry, Mebbin, Mooball, Mount Jerusalem, Mount Warning, and Nightcap

Habitat requirements

Records of *Endiandra hayesii* are usually from the poorer soils derived from sedimentary, metamorphic or acid volcanic rocks. Vegetation includes subtropical

and warm temperate rainforests and Brush Box forests, including regrowth and highly modified forms of these habitats. The altitude varies from near sea-level to 800 m (DEC 2007).

Endiandra hayesii has small inconspicuous flowers and is likely to be insect pollinated, as with other Lauraceae species. (DEC 2004d). Flowering times are March, May, October and November, and the species is rarely observed in fruit, possibly because they fruit only at long or irregular inter-annual periods, as with many other Laurels (DEC 2004d). It is thought that the fruit is likely to be dispersed by birds (DEC 2004d). There have been no observations of seedling emergence of this species in the field (DEC 2004d).

In regrowth forests of the local area, many plants of *Endiandra hayesii* recorded are small saplings and immature trees, suggesting that good regeneration, which may be episodic, is taking place. Saplings and immature trees have also been recorded in association with mature trees in hinterland locations (DEC 2004d).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Endiandra hayesii* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Endiandra hayesii.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Endiandra hayesii*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in a Vegetation Management Plan.
- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. However, as a precaution, weed control works would be detailed in the Vegetation Management Plan.However, as a precaution, weed control works should be detailed in a Vegetation Management Plan.

A Recovery Plan has been prepared for *Endiandra hayesii* (DEC 2004e), and lists nine objectives to assist in the recovery of the species. Those relevant to the

proposed upgrade include:

- To manage and protect the *Endiandra hayesii* and associated habitat from threatening processes – potential habitat for the species would be impacted by the proposed upgrade; and,
- Fire planning and management – the proposed upgrade is not likely to alter the fire frequency within the local area.

The Recovery Plan lists the following threats to *Endiandra hayesii* (DEC 2004e):

- Habitat clearing and fragmentation;
- Loss of genetic variation;
- Genetic issues; and,
- Collection for the bush food and nursery industry.

Roads, and specifically Pacific Highway upgrades, are listed in the Recovery Plan as a mechanism that could increase the threat of fragmentation to habitat Endiandra hayesii. The proposed upgrade would not increase fragmentation of habitat of Endiandra hayesii, as potential habitat that will be disturbed as part of the proposed upgrade consists of 12 small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of this species.

Local and regional abundance

Records of *Endiandra hayesii* are clustered in the Border Ranges, Nightcap Ranges and surrounds, and at a few scattered near-coastal locations. In Queensland, the species is apparently very rare, with locations reported only at Burleigh Heads, Tallebudgera and Springbrook (DEC 2004d).

In total, 83 locations for *Endiandra hayseii* and a closely associated species *Endiandra muelleri* ssp. *bracteata* are documented. Abundance data is available for only a small proportion of sites for this species (DEC 2004d).

Some of the near-coastal locations are known to consist only of a small number of stems, while regrowth forest in the Sleepy Hollow and Brunswick Heads areas is known to include moderate numbers of stems mainly in the medium and small size classes. Counts or estimates will be required from a larger sample of locations to enable population sizes to be estimated for this species (DEC 2004d).

Five known records of this species occur within 10 km of the study area (Figure 3).

Locations relative to limits of distribution

Endiandra hayesii has a restricted distribution in northern NSW and southern Queensland (DEC 2004d). The Clarence River is thought to be the southern limit of the species. In Queensland, the species is apparently very rare, with locations reported only at Burleigh Heads, Tallebudgera and Springbrook (DEC 2004d). The study area is not near the known limit of distribution for this species.

Habitat (within study area)

There are no known records of the species within the patches of vegetation within the study area.

Habitat for this species within the study area includes Lowland Rainforest. This habitat occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004h), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Endiandra hayesii was not detected during field surveys within the study area. Potential habitat for *Endiandra hayesii* occurs in Lowland Rainforest in the study area. The removal of 2.0 ha of vegetation that is potential habitat for *Elaeocarpus williamsianus*, with a further 3.6 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy for the species given that no known individuals of the species would be impacted and that there is approximately 776 ha of Rainforest (NPWS 1997b) and a large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only a small area of potential habitat for this species within the local area would be directly impacted by the proposed upgrade, the fact that the species was not recorded during field surveys and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species, it is considered unlikely that a viable local population of *Endiandra hayesii* would be placed at risk of extinction by the proposed upgrade.

Endiandra muelleri ssp. *bracteata*

Description

Endiandra muelleri ssp. *bracteata* is a tree up to 30 m tall with brown bark, often with loose round plates. Twigs and branchlets are covered in hairs. The moderately glossy leaves are oval or drawn out towards the tips, and measure 6 – 12 cm long and 3 – 5 cm wide, with three to five pairs of side veins. Flushes of new growth are pinkish-green. Flowers are small, yellowish and hairless, and are held in small clusters. The fleshy fruits are egg-shaped, 2.5 – 3 cm long and black when ripe (DEC 2005y).

Conservation status

Endiandra muelleri ssp. *bracteata* is listed as Endangered on the TSC Act.

Records of *Endiandra muelleri* ssp. *bracteata* are known from the Nature Reserves of Billinudgel, Broken Head, Brunswick Heads, Inner Pocket, Limpinwood, Numinbah and Snows Gully, and the National Parks of Border Ranges, Goonengerry, Mebbin, Mooball, Mount Jerusalem, Mount Warning, and Nightcap. The species is also known to occur within roadside reserves managed by Tweed and Byron Shire Councils (DEC 2004d). The Atlas of NSW Wildlife (DEC 2007) also has records of the species within Washpool National Park and Wollumbin National Park.

Records of the species are also known from within areas impacted by both the Pacific Highway upgrade between Brunswick Heads to Yelgun and the Yelgun to Chinderah Freeway within the Byron and Tweed LGA's. Other occurrences of the

species are on private land (DEC 2004d).

Habitat requirements

Records are usually from the poorer soils derived from sedimentary, metamorphic or acid volcanic rocks. Vegetation includes subtropical and warm temperate rainforests and Brush Box forests, including regrowth and highly modified forms of these habitats. The altitude varies from near sea-level to 800 m (DEC 2007).

The species has small inconspicuous flowers and is likely to be insect pollinated, as with other Lauraceae species. (DEC 2004d). Flowering times are March, May, October and November, and the species is rarely observed in fruit, possibly because they fruit only at long or irregular inter-annual periods, as with many other Laurels (DEC 2004d). It is thought that the fruit is likely to be dispersed by birds (DEC 2004d). There have been no observations of seedling emergence from this species in the field (DEC 2004d).

In regrowth forests of the local area, many plants recorded are small saplings and immature trees, suggesting that good regeneration, which may be episodic, is taking place. Saplings and immature trees have also been recorded in association with mature trees in hinterland locations (DEC 2004d).

Key Threatening Processes, Recovery and Threat Abatement Plans

Habitat clearing and fragmentation for agriculture, development and infrastructure are believed to be the main threats to the species (DEC 2004d). Other threats to the species include low numbers leading to vulnerability to the effects of chance catastrophic events; weed invasion, particularly *Lantana camara* and *Cinnamomum camphora*; loss of genetic variation threatening the evolutionary potential of the species; collection of propagation material; and, lack of information about threats (DEC 2004d).

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Endiandra muelleri* ssp. *bracteata* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Endiandra muelleri* ssp. bracteata.
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Endiandra muelleri* ssp. *bracteata*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that

provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara - Endiandra muelleri* ssp. *bracteata* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

A Recovery Plan for *Endiandra muelleri* ssp. *bracteata* has been prepared (DEC 2004d). DECC (DEC 2004d) propose a number of recovery objectives that would assist in the recovery of the species. Those relevant to the project include:

- Manage and protect the species and associated habitat from threatening processes, including controlling weed species in habitat for the species and protection of roadside populations of the species – weed control works should be detailed in a Vegetation Management Plan. There are no known roadside populations of the species in the study area

- Fire and planning management – the proposed upgrade is not likely to alter the fire regime within the species habitat in the local area.

No individuals of *Endiandra muelleri* ssp. *bracteata* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

In total, 83 locations for *Endiandra muelleri* ssp. *bracteata* and a closely associated species *Endiandra hayseii* are documented. Abundance data are available for only a small proportion of sites for this species (DEC 2004d).

Some of the near-coastal locations are known to consist only of a small number of stems, while regrowth forest in the Sleepy Hollow and Brunswick Heads areas is known to include moderate numbers of stems mainly in the medium and small size classes. Counts or estimates will be required from a larger sample of locations to enable population sizes to be estimated for this species (DEC 2004d).

According to the Atlas of NSW Wildlife online database (DEC 2007), there are 147 known locations of the species in northern NSW, the majority of which occur north of the study area near Byron Bay and Tweed. There are also records of the species further south in the Tenterfield and Grafton area (DEC 2007, NSW Government 2007).

Thirty records of the species are known from within a 10 km radius of the subject site, located approximately 5 km to the east of the study area in and around Broken Head Nature Reserve.

Locations relative to limits of distribution

Endiandra muelleri ssp. *bracteata* is known from north-eastern NSW, north from the Clarence River to southern and central Queensland (DEC 2004d). The species is moderately common in Queensland (DEC 2004d). In NSW, records are concentrated on the Tweed and Byron coasts, but also extend inland to the hinterland ranges, and south to Tuckean, Bungawalbin and Maclean (DEC 2004d).

The Atlas of NSW Wildlife (DEC 2007) shows a location of the species to the south-west of the study area in the Glen Innes-Severn and Clarence Valley area. Ballina is, the southern most limit of the species distribution along the coast. The study area is near the south-eastern limit of distribution for the species.

Habitat (within study area)

Endiandra muelleri ssp. *bracteata* was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest. This habitat occurs as small, fragmented patches which were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2005h), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Endiandra muelleri* ssp. *bracteata*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Endiandra muelleri* ssp. *bracteata* would be placed at risk of extinction by the proposed upgrade.

Floydia praealta

Description

Floydia praealta is a tree that grows to 35 m tall, with rough, brown, slightly wrinkled bark. It is closely related to the Macadamia. The leaves are 10 – 25 cm long and 1 – 3 cm wide, tapering at the bases but rounded at the tips, and with slightly wavy margins. They are shiny green and leathery, without hairs. The flower buds are creamy brown, and when open are cream and spidery with a musky odour. The woody, globular, brown fruit is 5 cm in diameter and contains one or two inedible seeds (DEC 2005g).

Conservation status

Floydia praealta is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VC-, indicating:

3 = A geographic range of >100 km

V =Vulnerable species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded at a number of reserves in the North Coast of NSW, including Mount Warning National Park, Numinbah Nature Reserve, Broken Head Nature Reserve, Hayters Hill Nature Reserve (DEC 2007).

Habitat requirements

The species is known to occur in riverine and subtropical rainforest, usually on soils derived from basalt (DEC 2005g).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005g):

- Clearing and fragmentation of habitat for coastal development, agriculture, roadworks and powerlines.
- Risk of local extinctions because populations are small and sparsely distributed.
- Infestation of habitat by weeds.
- Grazing and trampling of seedlings and saplings by domestic stock, particularly around remnant paddock trees.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Floydia praealta* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Floydia praealta*.
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Floydia praealta*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

To date, a Recovery Plan has not been prepared for *Floydia praealta*. DECC (DEC 2005g) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Identify populations along roadsides and powerline easements and protect them during works – no plants of *Floydia praealta* were identified in the study area.
- Remove weeds where they threaten adult plants or regeneration – weed

control works should be detailed in a Vegetation Management Plan. There are no known roadside populations of the species in the study area.

- Protect areas of habitat from clearing or development – potential habitat for the species would be impacted by the proposed upgrade.

No individuals of *Floydia praealta* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

Within its distribution, *Floydia praealta* is known to occur as small scattered populations (DEC 2005g). In total, 56 locations of the species occur in northern NSW, all of which occur around the Ballina, Byron Bay, Tweed areas (DEC 2007). The species is restricted to within 45 km of the coast in the local area (DEC 2005g). There is also a single record of the species further south in Sydney (NSW Government 2007).

Seventeen records of the species are known to occur within a 10 km radius of the study area, the closest of which occurs approximately 1 km to the west of the subject site.

Locations relative to limits of distribution

Floydia praealta is distributed from Gympie in Queensland to the Clarence River in north-east NSW (DEC 2005g). The distribution map from the Atlas of NSW Wildlife, shows Ballina as occurring near the southernmost limit of the species (DEC 2007). The study area is near the southern limit of distribution for the species.

Habitat (within study area)

Floydia praealta was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Floydia praealta*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Floydia praealta* would be placed at risk of extinction by the proposed upgrade.

Gossia fragrantissima

Description

Gossia fragrantissima is a multi-stemmed shrub or small tree, about 4 –10 m tall. The bark is rough, brown and fissured to flaky. Its small, glossy leaves usually have a tiny point at the apex and are paired on the stem. New leaves are shiny and reddish. The flowers are small, white and fragrant and are followed by small, round, yellow to orange berries (DEC 2005œ).

Conservation status

Gossia fragrantissima is listed as Endangered on both the TSC and EPBC Acts.

The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3EC-, indicating:

3 = A geographic range of >100 km

E =Endangered species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded in Boatharbour Nature Reserve (DEC 2007) in North Coast NSW. This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Gossia fragrantissima is known to occur in dry subtropical and riverine rainforest (DEC 2005œ). As the species can coppice from roots left in the ground when rainforest is cleared, it is found at several sites as isolated plants in paddocks or regrowth (DEC 2005). The species is mostly found on basalt-derived soils (DEC 2005œ).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005œ):

- Habitat degradation through weed invasion and disturbance.
- Loss of habitat through clearing and fragmentation.
- Risk of local extinction because populations are small.
- Grazing by domestic stock.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Gossia fragrantissima* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Gossia fragrantissima.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Gossia fragrantissima*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most

remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- Exotic vines and Scramblers – The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects.

- *Lantana camara - Gossia fragrantissima* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, a Recovery Plan has not been prepared for *Gossia fragrantissima*. DECC (DEC 2005œ) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Control weeds in dry subtropical and riverine rainforest – weed control works should be detailed in a Vegetation Management Plan. There are no known roadside populations of the species in the study area.

- Protect areas of rainforest habitat – potential habitat for the species would be impacted by the proposed upgrade.

No individuals of *Gossia fragrantissima* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

In total, 172 locations of the species occur in northern NSW, which occur between Evans Head and Tweed Heads along the coast and as far west as Lismore and Casino (DEC 2007). There is also a record of the species further south near Grafton (NSW Government 2007).

Ten records of the species are known to occur within a 10 km radius of the study area, one of which has count information indicating that the record represents one individual. The closest known population of the species occurs approximately 750 m to the east of the subject site

Locations relative to limits of distribution

The species occurs in south-east Queensland and in north-east NSW south to the

Richmond River (DEC 2005œ). The species distribution is bounded by southern Queensland in the north, Evans Head in the south and Casino in the west (DEC 2007). The study area is not at the known limit of distribution for this species.

Habitat (within study area)

Gossia fragrantissima was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Gossia fragrantissima*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species

was not recorded during field surveys, it is considered unlikely that a viable local population of *Gossia fragrantissima* would be placed at risk of extinction by the proposed upgrade.

Grevillea hilliana

Description

Grevillea hilliana is a rainforest tree 8 – 30 m tall. The young leaves are deeply lobed and mostly 25 – 40 cm long and 15 – 30 cm wide, while the adult leaves are often without lobes. The lower surface of both the young and the adult leaves is silvery and silky. The white to pale-green flower heads are cylindrical, 8 – 22 cm long and appear mainly during May to July (DEC 2005z).

Conservation status

Grevillea hilliana is listed as Endangered on the TSC Act.

Grevillea hilliana is only reserved in the Brunswick Heads Nature Reserve where a few trees are known (NSW Scientific Committee 2001). The other few known remaining areas are on private land and these are threatened with loss of habitat through land clearing (NSW Scientific Committee 2001). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Grevillea hilliana grows in subtropical rainforest, often on basalt-derived soils (DEC 2005z).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005z):

- Risk of extinction because populations are small and distribution is restricted.
- Loss of habitat through clearing for development.
- Habitat degradation through invasion by introduced weeds.
- Seed collection for horticulture.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Grevillea hilliana* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing

native vegetation that is potential habitat for *Grevillea hilliana*.

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Grevillea hilliana*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- Exotic vines and Scramblers –The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. Weed control works should be detailed in the Vegetation Management Plan.

To date, a Recovery Plan has not been prepared for *Grevillea hilliana*. DECC (DEC 2005z) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Prevent weeds and garden plants from invading habitat – weed control works should be detailed in a Vegetation Management Plan.

- Protect remnant rainforest areas from development – potential habitat for the species would be impacted by the proposed upgrade.

No individuals of *Grevillea hilliana* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

The number of known plants of *Grevillea hilliana* is low and is estimated to be less than 100 mature individuals (NSW Scientific Committee 2001). *Grevillea hilliana* is at risk of extinction in New South Wales due to its restricted distribution and very low population numbers (NSW Scientific Committee 2001).

In total, 24 locations of the species occur in northern NSW, distributed between Byron Bay and Tweed Heads (DEC 2007).

One records of the species is known to occur within a 10 km radius of study area (Figure 3), occurring approximately 6 km to the east of the subject site

Locations relative to limits of distribution

The species occurs north from Brunswick Heads on the north coast of NSW and in Queensland (DEC 2005z). The only populations currently known in NSW are near Brunswick Heads and on the slopes of Mt Chincogan in the Byron Shire and, in Tweed Shire in remnant patches of habitat, particularly around Terranora (DEC 2005).The study area is at the limit of distribution for this species.

Habitat (within study area)

Grevillea hilliana was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Grevillea hilliana*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed

bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Grevillea hilliana* would be placed at risk of extinction by the proposed upgrade.

Hibbertia hexandra

Description

Hibbertia hexandra grows as a tall shrub to small tree with star-shaped hair-clusters on the branches. The leaves are elliptical and alternate, 20 – 60 mm long and 5 – 15 mm wide with rounded tips. Showy yellow flowers with 5 petals are produced in spring. The fruit is a dry pod, splitting at the top to expose the seeds (DEC 2005~).

Conservation status

Hibbertia hexandra is listed as Endangered on the TSC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3RC-, indicating:

3 = A geographic range of >100 km

R =Rare species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

In north coast NSW, the species is known to occur in Whian Whian State Conservation Area and Mount Warning and Nightcap National Parks (DEC 2005~, 2007). Further south, in mid-coast NSW, the species occurs within Willi Willi National Park and Coorabakh National Park (DEC 2007). The species is not considered to be adequately conserved in the region.

Habitat requirements

Hibbertia hexandra typically grows in heath, open forest or rainforest (DEC

2005~).

Key Threatening Processes, Recovery and Threat Abatement Plans

The species is threatened by isolation of populations; trampling by tourist activities; timber harvesting activities; and, inappropriate fire regimes, which do not encourage regeneration of the species (DEC 2005~).

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Hibbertia hexandra* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Hibbertia hexandra.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Hibbertia hexandra*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

To date, a Recovery Plan for *Hibbertia hexandra* has not been prepared. DECC (DEC 2005~) recommend a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Manage fire to encourage regeneration of *Hibbertia hexandra* – the proposed upgrade is not likely to alter the fire frequency within the local area.
- Identify and protect populations during timber harvesting activities and road-works – potential habitat for the species will be cleared for the proposed upgrade.

No individuals of *Hibbertia hexandra* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

Eighteen records of the species are known to occur in NSW, all but one of which are mapped as occurring in conservation reserves (DEC 2007). In the region, the species occurs as two distinct populations, one in the Lismore/Byron area, where

most of the records occur within Whian Whian State Conservation Area and Mount Warning and Nightcap National Parks; and the other in the Taree area, where most records occur within Willi Willi National Park and Coorabakh National Park (DEC 2005~, 2007).

Ten records of the species occur in the local area, one of which occurs in the Byron Bay area. The remaining nine records occur within conservation reserves in the Lismore area (DEC 2007).

There is one known record of the species within a 10 k radius of the study area, occurring approximately 3 km to the west of the subject site

Locations relative to limits of distribution

The main occurrence of *Hibbertia hexandra* is in the coastal ranges of the Mount Warning area of north-east NSW (DEC 2005~). However, there is an important separate occurrence in the Wauchope–Kendall area, which may be a new species (DEC 2005~). The species is not considered to be near the limit of the known distribution for the species.

Habitat (within study area)

Hibbertia hexandra was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest. This habitat occurs as small, fragmented patches, which were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Hibbertia hexandra*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation

of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Hibbertia hexandra* would be placed at risk of extinction by the proposed upgrade.

Hicksbeachia pinnatifolia

Description

Hicksbeachia pinnatifolia is a small tree to 10 m tall, often with several unbranched stems rising from the rootstock. The leaves are leathery and compound, each 40 – 100 cm long, deeply lobed, or with many leaflets and a winged central spine. The lobes or leaflets have prickly toothed margins and the veins are prominent on both sides. A loose spike of many spidery-flowers, 15 – 35 cm long, arises directly from the trunk from ground level upwards. The flowers are purplish brown with a strong, sickly scent. Bright red fleshy fruits, 2 – 4 cm long, follow the flowers (DEC 2005‹).

Conservation status

Hicksbeachia pinnatifolia is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3RC-, indicating:

3 = A geographic range of >100 km

R =Rare species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

Records of *Hicksbeachia pinnatifolia* are known from a number of conservation reserves in the region, including Couchy Creek Nature Reserve, Nightcap National Park and Mount Jerusalem National Park in the Byron Bay/Tweed area (DEC 2007). The species is not considered to be adequately reserved in the region.

Habitat requirements

The species is known to occur in subtropical rainforest, moist eucalypt forest and Brush Box forest, but can also persist in disturbed areas including roadsides (DEC 2005‹).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005‹): clearing of rainforest habitat for development or agriculture; invasion of habitat by introduced weeds, particularly Lantana and exotic vines; fire; and, collection of seed for horticulture.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Hicksbeachia pinnatifolia* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Hicksbeachia pinnatifolia*.
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Hicksbeachia pinnatifolia*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Exotic vines and Scramblers – *Hicksbeachia pinnatifolia* is specifically listed as a species impacted by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects.

- *Lantana camara - Hicksbeachia pinnatifolia* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, a Recovery Plan for *Hicksbeachia pinnatifolia* has not been prepared. The DECC (DEC 2005‹) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Protect rainforest, moist eucalypt forest and Bush Box forest from fire - the proposed upgrade is not likely to alter the fire regime within the species habitat in the local area.

- Control introduced weeds - weed control works should be detailed in a Vegetation Management Plan.

- Protect remnant subtropical rainforest habitat – potential habitat for the species is required to be cleared as part of the proposed upgrade.

No individuals of *Hicksbeachia pinnatifolia* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

In total, 222 locations for *Hicksbeachia pinnatifolia* occur in NSW (DEC 2007), the majority of which occur to the north of the subject site in the Byron area. Scattered locations of the species also occur to the south of the subject site in the Coffs Harbour area (DEC 2007, NSW Government 2007). There is also a record of the species to the north-west of the study area near the NSW Queensland border in the McPherson Ranges (NSW Government 2007).

There are 11 previous records of the species within 10 km of the study area.The nearest recordings are within 3 km to the west of the townships of Newrybar and Bangalow (Figure 3).

Locations relative to limits of distribution

Hicksbeachia pinnatifolia is known from the coastal areas of north-east NSW from the Nambucca Valley north to south-east Queensland (DEC 2005‹). The study area is not considered to be at the limit of known distribution for the species.

The Atlas of NSW Wildlife (DEC 2007) shows the majority of records occurring in the Byron area, with a single record also occurring to the south of the study area at

Coffs Harbour.

Habitat (within study area)

Hicksbeachia pinnatifolia was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest. This habitat occurs as small, fragmented patches which were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2005‹), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Hicksbeachia pinnatifolia*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.03% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for this species will not be further fragmented by the proposed upgrade, as existing vegetation is already highly fragmented. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species

was not recorded during field surveys, it is considered unlikely that a viable local population of *Hicksbeachia pinnatifolia* would be placed at risk of extinction by the proposed upgrade.

Isoglossa eranthemoides

Description

Isoglossa eranthemoides is a herb that grows to 50 cm tall. Its paired leaves are oval or more elongated and 2 – 16 cm long. The white-petalled flowers are about 12 mm across, and are borne in clusters towards the tops of the stems. The five petals are of three kinds: two are erect, two droop to the sides and a central tube-like structure has three lobes. The capsules are up to 12 mm long, and tapered at each end to form an elongated diamond shape. They spring open, expelling seeds explosively (DEC 2005).

Conservation status

Isoglossa eranthemoides is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2E, indicating:

2 = A geographic range of <100 km

E =Endangered species

The species has been recorded in a number of conservation reserves in the region, including Mount Warning National Park, Wollumbin National Park, Inner Pocket Nature Reserve and Andrew Johnston Big Scrub Nature Reserve (DEC 2007). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Isoglossa eranthemoides is known to occur in the understorey of lowland subtropical rainforest, in moist situations on floodplains and slopes (DEC 2005). The underlying soils are derived from basalt, metasediments or gabbro (DEC 2005).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005): risk of local extinction because populations are small; clearing and fragmentation of habitat from development, agriculture and roadworks; construction of walking tracks in areas of habitat; weed infestation; grazing by stock; and, inadvertent damage during bush regeneration.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Isoglossa eranthemoides* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Isoglossa eranthemoides.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Isoglossa eranthemoides*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Exotic vines and Scramblers – *Isoglossa eranthemoides* is specifically listed as a species impacted by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects.
- *Lantana camara - Isoglossa eranthemoides* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, a Recovery Plan has not been prepared for *Isoglossa eranthemoides*. DECC (DEC 2005) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Protect areas of rainforest habitat from clearing or development– potential habitat for the species would be impacted by the proposed upgrade.

No individuals of *Isoglossa eranthemoides* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

In total, 36 locations of the species occur in northern NSW, with the majority of

records located around the Byron and Tweed areas (DEC 2007).

Thirteen known records of the species occur within a 10 km radius of the study area, six of which have count information, ranging between 100 and 1500 plants (DEC 2007).

Locations relative to limits of distribution

The species has a very restricted distribution in north-east NSW from the Tweed to the Lismore area, with a single uncertain historical report from south-east Queensland (DEC 2005). The study area is at the southern limit of the known distribution of the species (DEC 2007).

Habitat (within study area)

Isoglossa eranthemoides was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Isoglossa eranthemoides*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as

the species was not recorded in the study area.

Potential habitat for *Isoglossa eranthemoides* that will be disturbed as part of the proposed upgrade consists of small, isolated patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Isoglossa eranthemoides* would be placed at risk of extinction by the proposed upgrade.

Macadamia tetraphylla

Description

Macadamia tetraphylla is a small to medium-sized, usually densely bushy, tree growing up to 18m tall. The leaves are 7 – 25 cm long and oblong or slightly lance-shaped. The leaf-margins are toothed and prickly. Creamy pink to purplish flowers hang in long strings among the leaves. The fruit is woody brown and globular, 2 – 3 cm in diameter. The edible seeds are enclosed in a hard, wrinkled, brown shell inside a round green husk. Most commercial macadamias are hybrids of this species and the Queensland species *Macadamia integrifolia* (DEC 2005).

Conservation status

Macadamia tetraphylla is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2VC-, indicating:

2 = A geographic range of <100 km

V =Vulnerable species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded in a number of conservation reserves in the region, including Whian Whian State Conservation Area, Limpinwood Nature Reserve, Numinbah Nature Reserve and Mooball National Park (DEC 2007). This species is not considered to be adequately conserved within conservation reserves in the

region.

Habitat requirements

Macadamia tetraphylla is found in subtropical rainforest (regrowth or remnant) usually near the coast (DEC 2005).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005): clearing and fragmentation of habitat for coastal development, agriculture and roadworks; risk of local extinction due to low numbers; grazing and trampling by domestic stock; fire; invasion of habitat by weeds; and, loss of local genetic strains through hybridisation with commercial varieties.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Macadamia tetraphylla* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is habitat for *Macadamia tetraphylla.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Macadamia tetraphylla*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara - Macadamia tetraphylla* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, a Recovery Plan has not been prepared for *Macadamia tetraphylla*. DECC (DEC 2005) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Protect rainforest from fire – the proposed upgrade is not likely to alter the frequency of fire in the local area.

- Control weeds in rainforest areas - Weed control works should be detailed in the Vegetation Management Plan.

- Protect areas of rainforest habitat from clearing or development – potential habitat for the species would be impacted by the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of the species, given the numerous records of the species in the local area and only one record will be indirectly impacted.

Local and regional abundance

In total, 216 locations of the species occur in northern NSW, with the majority of records occurring in the Tweed/Byron/Ballina area. Three records of the species also occur south of the study area in the Coffs Harbour and Clarence Valley areas (DEC 2007). There is also a single record of the species in the Sydney area, likely to be a planting (NSW Government 2007).

This species has been recorded within the study area at six locations to the south and west of the township of Knockrow within the study area, one in a patch of Camphor Laurel, three in patches of Lowland Rainforest and two as scattered trees in a garden landscape. One recording is on the perimeter of the proposed upgrade to the west of Knockrow and one record is within 50 m of the edge of the corridor. The two remaining records are outside of the area of direct and indirect impacts.

Ninety seven recordings of this species occur within a 10 km radius of the subject site, many of which are within close proximity to commercial Macadamia plantations.

A number of individuals of this species were recorded in the local area during the field surveys. One of which would be indirectly impacted by the proposed upgrade, which occurs as an isolated tree within a garden area (Figure 3).

Locations relative to limits of distribution

The species is confined chiefly to the Richmond and Tweed Rivers in north-east NSW, extending just across the border into Queensland (DEC 2005). The majority of records of the species occur in the Tweed/Byron/Ballina area, with three records also occurring south of the study area in the Coffs Harbour and Clarence Valley areas (DEC 2007). The study area is considered to be at the limit of the known distribution of the species (DEC 2007).

Habitat (within study area)

One known record of *Macadamia tetraphylla* is located within the study area.This record represents a planted individual in a garden landscape near Patch 12. There

are various other records in the general vicinity, but outside the study area.Within the study area, potential habitat for this species is also considered to be within patches of Lowland Rainforest and Camphor Laurel.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

One known record of *Macadamia tetraphylla* would be indirectly impacted by the proposed upgrade, with no records directly impacted. Potential habitat for *Macadamia tetraphylla* occurs in patches of Lowland Rainforest and Camphor Laurel in the study area.The removal of 7.7 ha of vegetation that is potential habitat, with a further 20.8 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species given the density of records in the local area and the fact that there is approximately 776 ha of Rainforest (NPWS 1997b) and a large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and modification of habitat in the study area.Disruption to the lifecycle of one individual of the species is unlikely to impact on the long-term viability of the species in the local area given the number of records of the species in the local area.

Potential habitat for *Macadamia tetraphylla* that would be directly impacted as part of the proposed upgrade consists of approximately six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Macadamia tetraphylla* or any potential habitat for the species.

Given that one plant of the species will be indirectly impacted, the proposed upgrade is not likely to fragment an existing population and potential habitat to be impacted is in poor condition and not likely to be important to the long term

survival of the species, it is considered unlikely that a viable local population of *Macadamia tetraphylla* would be placed at risk of extinction by the proposed upgrade. Further, indirect impacts to the species will be minimised through the implementation of mitigation measures.

Marsdenia longiloba

Description

Marsdenia longiloba is a slender climber of the milk vine group, with pairs of very finely pointed leaves and 5-6 tiny glands at the base of the leaves. The stems of this species exude clear, watery sap when cut, unlike most of the Milk Vines which have milky sap. Clusters of small white star-shaped flowers are produced in summer and are followed by long, narrow seed-capsules that split to release many seeds with tufts of long silky hair (DEC 2005“).

Conservation status

Marsdenia longiloba is listed as Endangered on the TSC Act and as Vulnerable on the EPBC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3RC-, indicating:

2 = A geographic range of <100 km

R = Rare species

C = Population reserved

- = adequacy of reservation unknown

The species has been recorded in a number of conservation reserves in the region, including Barrington Tops National Park, Boonanghi Nature Reserve, Gibraltar Range National Park, Yabbra National Park and Brunswick Heads Nature Reserve (DEC 2007).

Habitat requirements

Marsdenia longiloba is known to occur in Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops (DEC 2005“).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005“): loss and fragmentation of habitat through land clearing for agriculture and urban development; risk of local extinction because populations are small; invasion of habitat by introduced weeds;

grazing and trampling of plants by cattle; and, use of herbicides.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Marsdenia longiloba* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Marsdenia longiloba.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Marsdenia longiloba*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Exotic vines and Scramblers – The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects.
- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Marsdenia longiloba.* The DECC (DEC 2005“) lists a number of recovery actions for this species. Those that apply to the study area include:

- Control weeds likely to spread into suitable habitat – Weed control works should be detailed in a Vegetation Management Plan;
- Limit use of herbicides to areas away from significant native vegetation; and,
- Protect areas of habitat from clearing – potential habitat for the species would be impacted by the proposed upgrade.

No individuals of *Marsdenia longiloba* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

In total, 70 locations of the species occur in northern NSW, with the majority of records located around the Coffs Harbour area (DEC 2007).

This species was not recorded within the Subject Site, and no previous recordings are known from within the study area (Figure 3). One recorded location of this species exists approximately 6.4 km east of the proposed upgrade, and south west of the Byron Bay Township.

Locations relative to limits of distribution

The species occurs at scattered sites on the north coast of NSW north from Barrington Tops and in south-east Queensland (DEC 2005“). The study area is not at the limit of the known distribution of the species.

Habitat (within study area)

Marsdenia longiloba was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Marsdenia longiloba*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the

Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Marsdenia longiloba* that will be disturbed as part of the proposed upgrade consists of small, isolated patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Marsdenia longiloba* would be placed at risk of extinction by the proposed upgrade.

Melicope vitiflora

Description

Melicope vitiflora is a small tree up to 14 m high. The leaf is divided into three oval-shaped leaflets that are 10-20cm long, and are soft and moderately thick. These leaflets are narrowed at the apex and base. The midrib and lateral veins are distinct, especially on the lower surface. The leaves have many obvious oil dots. The main leaf stem is 2-14 cm long. The two side leaflets have short (3-12 mm) stems; however, the stem of the middle leaflet is much longer (7-25 mm) and is jointed near the apex. The branchlets are finely hairy and flattened where they join the stem. The small white flowers occur in a clump at the end of the branch; seeds are shiny, black and held in a capsule. Flowers occur in late spring to early summer (DEC 2005—).

Conservation status

Melicope vitiflora is listed as Endangered on the TSC Act.

In NSW, the species is known from the following conservation reserves: Broken Head Nature Reserve, Brunswick Heads Nature Reserve and Whian Whian State Conservation Area (DEC 2005—).

Habitat requirements

Melicope vitiflora grows in subtropical and littoral rainforest (DEC 2005—).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species are listed as (DEC 2005—): clearing of habitat; risk of extinction due to small population size; fire; and weed invasion, particularly by Lantana and exotic vines.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Melicope vitiflora* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Melicope vitiflora.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Melicope vitiflora*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Exotic vines and Scramblers – The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects.
- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Melicope vitiflora.* The DECC (DEC 2005—) lists a number of recovery actions for this species. Those that apply to the study area include:

- Prevent fire from spreading into rainforest habitats – the proposed upgrade is not likely to alter fire frequency in the local area.
- Control weeds in known and potential habitat – Weed control works should be detailed in a Vegetation Management Plan;
- Protect remnant areas of subtropical and littoral rainforest from clearing and fragmentation – potential habitat for the species would be impacted by the

proposed upgrade.

No individuals of *Melicope vitiflora* are known to occur within the subject site and no known habitat for the species would be impacted. Therefore, the proposed upgrade is not likely to interfere with the recovery of the species.

Local and regional abundance

In New South Wales, *Melicope vitiflora* is known to be extant from five locations (NSW Scientific Committee 2002b). All populations of the species are thought to be small (DEC 2005—).

This species was not recorded in the study area.One recorded location of this species exists approximately 6 km east of the proposed upgrade.

Locations relative to limits of distribution

Melicope vitiflora occurs in Queensland and reaches its southern limit in NSW, where it is largely restricted to coastal areas around Brunswick Heads, Ocean Shores, Broken Head and the Nightcap Range (DEC 2005—). The study area is near the limit of the known distribution of the species.

Habitat (within study area)

Melicope vitiflora was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Melicope vitiflora*, with a further 3.6 ha of potential habitat within 50 m of the subject site. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Melicope vitiflora* that will be disturbed as part of the proposed upgrade consists of small, isolated patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Melicope vitiflora* would be placed at risk of extinction by the proposed upgrade.

Ochrosia moorei — Southern Ochrosia

Description

Ochrosia moorei is a small tree, sometimes crooked with several stems, growing up to 11 m tall. The bark is very dark brown, finely wrinkled and rough. The leaves are 8 – 20 cm long, arranged in twos or threes, varying in shape but tapering to a long point at the tips and gradually narrowing at the base. They are green and shiny, paler beneath, and thin in texture. When picked, the leaf-stalk exudes a milky sap. Small white flowers are held in small clusters at the ends of branchlets. The shiny scarlet fruit is oval-shaped and 4 – 8 cm long (DEC 2005—).

Conservation status

Ochrosia moorei is listed as Endangered on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2ECi, indicating:

2 = A geographic range of <100 km

E =Endangered species

C = Reserved, with a least one population in a national park

i = Less than 1000 plants are known to occur within a conservation reserve

The species has been recorded in a number of conservation reserves in the region, including Numinbah Nature Reserve, Mount Warning National Park, Wollumbin National Park, Snows Gully Nature Reserve and Nightcap National Park (DEC 2007). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Ochrosia moorei is known to occur in riverine and lowland subtropical rainforest (DEC 2005—).

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species include (DEC 2005—): clearing and fragmentation of habitat for coastal development, agriculture and roadworks; risk of local extinction because populations are small; invasion of habitat by introduced weeds; and collection of seed for horticulture.

A Recovery Plan for *Ochrosia moorei* has not yet been prepared. However, DECC (DEC 2005—) lists a number of actions to assist in recovery of the species. Those relevant to the proposed upgrade include:

- Assist with the removal of introduced weeds – weed control works should be detailed in a Vegetation Management Plan.
- Protect areas of rainforest habitat from clearing or development – the proposed upgrade would require clearing of potential habitat for this species.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Ochrosia moorei* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Ochrosia moorei*.
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Ochrosia moorei*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that

provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara - Ochrosia moorei* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

The proposed upgrade is not likely to interfere with the recovery of *Ochrosia moorei*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In total, 65 locations of the species occur in northern NSW, the majority of which are located within the Ballina/Byron/Tweed areas. There is also a single record of the species further west within the Kyogle area (DEC 2007).

Twenty four records of this species occur within a 10 km radius of the study area, the closest of which occurs approximately 750 m to the west of the subject site

Locations relative to limits of distribution

The species is found in north-east NSW north from the Richmond River, and in south-east Queensland (DEC 2005—). It is very sparsely distributed within this range (DEC 2005—). The study area is just north of the southern limit of known distribution of the species (DEC 2007).

Habitat (within study area)

Ochrosia moorei was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Ochrosia moorei*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area .

Potential habitat for *Ochrosia moorei* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Ochrosia moorei* would be placed at risk of extinction by the proposed upgrade.

Owenia cepiodora

Description

Owenia cepiodora is a tall evergreen tree, up to 30 m, with a dense glossy dark-green crown. Its bark is dark brown with vertical fissures. If the bark is cut, a pink-red underbark is exposed, and the tree exudes a red sap with a strong onion odour. The leaves are composed of 13 – 19 glossy dark green leaflets 10 – 15 cm long. Flowers are white, in clusters at the ends of branchlets. The globular red fruit are 15

– 20 mm wide, with white pulpy flesh surrounding a stone with one or two seeds. The timber resembles that of Red Cedar but has a characteristic onion odour (DEC 2005‡).

Conservation status

Owenia cepiodora is listed as Vulnerable on the TSC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2VCi, indicating:

2 = A geographic range of <100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

i = Less than 1000 plants are known to occur within a conservation reserve

The species has been recorded in a number of conservation reserves in the region, including Border Ranges National Park, Mebbin National Park, Whian Whian State Conservation Area, Mallanganee National Park (DEC 2007). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Owenia cepiodora is known to occur in subtropical and dry rainforest on or near soils derived from basalt (DEC 2005‡).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC (DEC 2005‡) lists the following threats to the species: clearing and fragmentation of habitat for development, agriculture, and road-works; grazing by domestic stock; fire; invasion of habitat by weeds, especially Lantana; climate change; activation of acid sulfate soils; and, removal of dead wood.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Owenia cepiodora* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Owenia cepiodora.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Owenia cepiodora.*
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion

by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara - Owenia cepiodora* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Owenia cepiodora.* The DECC (DEC 2005‡) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Protect rainforest areas from fire – the proposed upgrade is not likely to change the fire frequency of the local area;
- Remove weeds where they threaten adult plants or regeneration – weed control works will be included as part of the Vegetation Management Plan; and,
- Protect areas of rainforest habitat from clearing or development – potential habitat for the species will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Owenia cepiodora*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In total, 74 locations of the species occur in northern NSW, the majority of which are located within the Lismore/Tweed/Kyogle areas. There are also scattered records in the Ballina/Byron areas (DEC 2007). There is also a record of the species further south in the Gloucester area (NSW Government 2007).

There are five known records of this species occurring within a 10 km radius of the study area, two with count information indicating that each record represents one plant of the species. The closest known population of the species occurs approximately 1.5 km to the west of the subject site.

Locations relative to limits of distribution

The species is found north from the Richmond River in north-east NSW extending just across the border into Queensland (DEC 2005‡). The study area is near the

south-eastern limit of known distribution of the species (DEC 2007).

Habitat (within study area)

Owenia cepiodora was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Owenia cepiodora*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Owenia cepiodora* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species

was not recorded during field surveys, it is considered unlikely that a viable local population of *Owenia cepiodora* would be placed at risk of extinction by the proposed upgrade.

Phaius australis

Description

Phaius australis has flower stems up to 2 m tall and large broad leaves with a pleated appearance, both arising from a fleshy bulb near ground level. The large, showy flowers, with up to 20 per stem, have four petals which are white on the outside and brown with white or yellow veins on the inside. The central tongue of the flower is pink and yellow with lobes slightly curved inwards (DEC 2005˜).

Conservation status

Phaius australis is listed as Endangered on the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VCa, indicating:

3 = A geographic range of >100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

a = 1000 plants or more are known to occur within a conservation reserve(s)

The species has been recorded in conservation reserves in the region, including Bundjalung National Park and Broadwater National Park (DEC 2007). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Phaius australis is known to occur in swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas (DEC 2005˜).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC (DEC 2005˜) lists the following threats to the species: illegal collection for horticulture or cut flowers; clearing and fragmentation of habitat for development, agriculture and roadworks; drainage of swamps, or pollution from nutrient run-off; frequent fire; grazing and trampling by domestic stock and feral

pigs; and invasion of habitat by introduced weeds.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Phaius australis* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Phaius australis.*
- Ecological consequences of high frequency fires – *Phaius australis* is listed as a species known to be affected by this KTP (NSW Scientific Committee 2000b). The proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Phaius australis*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Feral Pigs - *Phaius australis* is listed as a species known to be affected by this KTP (NSW Scientific Committee 2004). The proposed upgrade is not likely to increase the threat of feral pigs in the local area.
- *Lantana camara* - *Phaius australis* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

A Draft Recovery Plan has been prepared for *Phaius australis.* The DECC (DEC 2005˜) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Protect areas of habitat from frequent fire – the proposed upgrade is not likely to change the fire frequency of the local area;
- Protect areas of habitat from pollution – runoff from the proposed upgrade may impact in adjoining areas of habitat;
- Control weeds – weed control works will be included as part of the Vegetation Management Plan; and,
- Protect areas of habitat from clearing, draining or development – potential

habitat for the species will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Phaius australis*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In 1999, there were about 14 known populations, only 50% of which have records of plant numbers (NSW Scientific Committee 1998d). Most populations had very few individuals with a total of only about 180 plants known in the wild (NSW Scientific Committee 1998d). This number has increased to 19 locations of the species, located in northern NSW, scattered along the coast from Coffs Harbour north to the Queensland border (DEC 2007). There is also a single record of the species in Sydney, likely to be a planting (NSW Government 2007)

Phaius australis has not been recorded in the study area.The species has, however, been recorded within a 10 km radius of the study area, with:

- Four recordings approximately 2 km east of the proposed upgrade, east and north-east of Bangalow.
- One recording approximately 9 km south-east of the proposed upgrade, south-east of Cumbalum.

Locations relative to limits of distribution

Phaius australis occurs chiefly north from the Evans Head District, though has been historically recorded as far south as Port Macquarie (Harden 1993). The northern limit is the Barron River in north-east Queensland, though most of the populations are on the mainland and the large sand islands off the south-east mainland of Queensland. In NSW, most of the populations are on the coast between Coffs Harbour and Ballina (NSW Scientific Committee 1998d). The study area is not at the limit of known distribution for the species (DEC 2007).

Habitat (within study area)

Phaius australis was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Phaius australis*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Phaius australis* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Phaius australis* would be placed at risk of extinction by the proposed upgrade.

Phyllanthus microcladus **Brush Sauropus**

Description

Phyllanthus microcladus is a small shrub to 35 cm tall, with stout main branches and small wedge-shaped or rounded leaves clustered on short, fine branchlets. The

lower surface of the leaves is sometimes softly hairy and has a prominent midrib. Flowers are small and inconspicuous. The fruit is a round smooth capsule, about 3 mm long, and hangs on a long thin stalk. Until recently the Brush Sauropus was known as *Sauropus albiflorus* subspecies *microcladus* (DEC 2005‰).

Conservation status

Phyllanthus microcladus is listed as Endangered on the TSC Act.

None of the records of the Atlas of NSW Wildlife were located within conservation reserves (DEC 2007). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Phyllanthus microcladus is usually found on banks of creeks and rivers, in streamside rainforest.

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC (DEC 2005‰) lists the following threats to the species: clearing and fragmentation of habitat for development and agriculture; risk of local extinction because populations are small; invasion of creekside habitat by introduced weeds; grazing and trampling by domestic stock; and, erosion of banks of creeks and rivers.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Phyllanthus microcladus* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Phyllanthus microcladus.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Phyllanthus microcladus*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara - Phyllanthus microcladus* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed

upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Phyllanthus microcladus.* The DECC (DEC 2005‰) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Remove weeds where they threaten adult plants or regeneration– weed control works will be included as part of the Vegetation Management Plan; and,

- Protect areas of streamside rainforest habitat from clearing or development– potential habitat for the species will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Phyllanthus microcladus*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In total, 43 locations of the species occur in NSW, the majority of which are located within the Byron area. There are also scattered records in the Richmond River and Clarence Valley areas (DEC 2007).

There are three known records of this species within a 10 km radius of the subject site, all of which occur approximately 8 km to the west of the subject site.

Locations relative to limits of distribution

In NSW the species is confined to a few locations in the Tweed, Brunswick, Richmond and Wilson River Valleys with an outlying population near Grafton (DEC 2005‰). The species also occurs in south-east Queensland (DEC 2005‰). The study area is not at the limit of known distribution for the species (DEC 2007).

Habitat (within study area)

Phyllanthus microcladus was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Phyllanthus microcladus*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Phyllanthus microcladus* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Phyllanthus microcladus* would be placed at risk of extinction by the proposed upgrade.

Randia moorei

Description

Randia moorei is a tall shrub or small tree to about 8 m tall, often with coppice shoots and root suckers at the base. Flowers are small and white, with a strong sweet smell, and develop into round yellow to orange berries which eventually turn black (DEC 2005™).

Conservation status

Randia moorei is listed as Endangered on both the TSC and EPBC Acts.

Randia moorei has been found in ten national parks and reserves. In NSW, it is known from Brunswick Heads Nature Reserve, and historic records exist from Broken Head Nature Reserve, Stotts Island Nature Reserve and Wilson's Park Nature Reserve, however these sites are yet to be reconfirmed. The species also occurs within Birds Bay Council Reserve. In Queensland, it is recorded from Burleigh Heads National Park, Darlington Reserve, Wongawallen Conservation Area, Nicoll's Scrub National Park and Upper Mudgeeraba Conservation Area (DEC 2004b). The current distribution and abundance of the species within this range is poorly understood (DEC 2004b).

Habitat requirements

Randia moorei grows in subtropical, riverine, littoral and dry rainforest; north from Lismore (Harden 1992, DEC 2005™). In NSW, Hoop Pine and Brush Box are common canopy species (DEC 2005™).

The following is a summary of the information about the life cycle of *Randia moorei*, detailed in the Recovery Plan for the species (DEC 2004b):

- Moderately slow growth rates have been observed in horticultural specimens of this species.
- The site at Brunswick Heads Nature Reserve is the largest known, with more than 60 individuals recorded. All size classes are represented at this site, occurring over a 0.4 ha area. Seedlings and/or small suckers are also present around several mature trees.
- *Randia moorei* coppices and produces root suckers readily, with suckers evident on many plants.
- The age at which *Randia moorei* is reproductively mature, and the time it takes the species to produce viable seed, are important biological variables. *Randia moorei* has been noted to fruit at six years old. Small shrubs (<1 m high) have been observed fruiting at Cudgera Creek and flower buds were present on a plant with dbh <1 cm at Tony's Island.
- The flowering period of *Randia moorei* has been recorded as July to October.
- Flower buds were recorded in May at Tony's Island.
- Fruiting times appear to be irregular in *Randia moorei*. Ripe fruit has been

recorded from July to August and December, as well as March from May to July and August.

- Fruit of the Rubiaceae family is readily dispersed by birds, although there are no known records of birds feeding on the fruit of *Randia moorei*. A proportion of the seeds are probably dispersed a distance from the parents and account for the scattered, isolated occurrences of plants which, seem to be typical of the Spiny Gardenia's distribution.

- Soil storage of seeds is likely to be transient in *Randia moorei* which is typical for species of later successional stages in rainforest environments.

- Seeds germinate readily after about 3 months and have a high rate of viability. However, seeds may lose viability quickly in the wild.

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the species include (DEC 2004b): habitat loss, habitat fragmentation, habitat degradation, weed removal, fire, mechanical disturbance, road maintenance, urban development and loss of genetic diversity.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Randia moorei* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Randia moorei*.

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Randia moorei*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara* - The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

A Recovery Plan for *Randia moorei* has been prepared (DEC 2004b). Seven recovery objectives have been listed to assist in the recovery of the species. One

relevant to the proposed upgrade is:

- To manage and protect *Randia moorei* populations and associated habitat – the proposed upgrade would result in clearing of potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of *Randia moorei*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In NSW, there are currently 33 verified sites known to support 121 mature plants and 98 juvenile plants. In Queensland there are 11 recorded sites supporting 15 individuals (DEC 2004b).

There are five known records of this species within a 10 km radius of the subject site.

Locations relative to limits of distribution

The known range of the species extends from Lismore on the north coast of NSW, northwards to the Logan River in southern Queensland. The current distribution and abundance of the species within this range is poorly understood. In NSW, most known records of *Randia moorei* are in the Tweed and Brunswick LGA's (DEC 2004b). The study area is near the limit of known distribution for the species.

Habitat (within study area)

Randia moorei was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Randia moorei*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small

area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Randia moorei* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Randia moorei* would be placed at risk of extinction by the proposed upgrade.

Senna acclinis

Description

Senna acclinis is a shrub to 3 m tall with compound leaves to 15 cm long, each with up to six pairs of oval-shaped leaflets at about 15 mm intervals along the central spine. There is a gland between the lower one to four pairs of leaflets. The flowers are in groups of two to five on a short stalk, hanging on the underside of the branchlets. They are bright golden yellow and cup-shaped. The seed pod is long and narrow, 12 - 15 cm long, 6 - 8 mm wide and more or less flat. *Senna acclinis* can easily be mistaken for introduced Senna (formerly Cassia) species which are environmental weeds (DEC 2005').

Conservation status

Senna acclinis is listed as Endangered on the TSC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3RC-, indicating:

3 = A geographic range of >100 km

R = Rare species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded in a number of conservation reserves in the region, including Barrington Tops National Park, Booti Booti National Park, Oxley Wild Rivers National Park, Ulidarra National Park, Sherwood Nature Reserve, Broken Head Nature Reserve, Wollumbin National Park, Mebbin National Park, Border Ranges National Park, Toonumbar National Park and Richmond Range National Park (DEC 2007). However, this species is not considered to be adequately conserved within conservation reserves in the region given that only 26 known locations of the species exist within the area (DEC 2007).

Habitat requirements

Senna acclinis grows in or on the edges of subtropical and dry rainforest (DEC 2005').

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC (DEC 2005') lists the following threats to the species: clearing of habitat for development; invasion by introduced weeds, particularly Lantana and exotic vines; timber harvesting activities; and, accidental removal during weed-control programs.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Senna acclinis* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Senna acclinis.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Senna acclinis*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

- *Lantana camara - Senna acclinis* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Senna acclinis*. The DECC (DEC 2005') lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Control and remove introduced weeds – weed control works will be included as part of the Vegetation Management Plan; and,
- Protect habitat from clearing and logging – potential habitat for the species will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Senna acclinis*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In total, 26 locations of the species occur in NSW (DEC 2007). There are three disjunct occurrences of the species in NSW. The northern most occurrence of the species extends from the coast in the Byron area west to Tenterfield. The second occurrence is located further south from Coffs Harbour on the coast, extending west to Armidale. The southernmost occurrence is located on the coast in the Great Lakes area, spreading west to Dungog (DEC 2007). The species is also known to occur further south in the Illawarra district (DEC 2005') (NSW Government 2007).

There are two known records of the species within a 10 km radius of the subject site.

Locations relative to limits of distribution

The species is located within coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland (DEC 2005'). The study area is not at the limit of known distribution of the species (DEC 2007).

Habitat (within study area)

Senna acclinis was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to

their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Senna acclinis*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Senna acclinis* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Senna acclinis* would be placed at risk of extinction by the proposed upgrade.

Sophora fraseri

Description

Sophora fraseri is a small sparsely branched shrub growing 1 - 2 m tall, which belongs to the pea family. The whole plant is covered in soft short hairs. Its leaves are 6 - 15 cm long, and consist of 21 - 35 leaflets. The pale yellow flowers have the shape of a typical pea flower, and are arranged in groups at the ends of branches. The seed pods are 3 - 10 cm long and contain two to six seeds (DEC 2005–).

Conservation status

Sophora fraseri is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VC-, indicating:

3 = A geographic range of >100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded the following conservation reserves in the region: Richmond Range National Park and Mount Warning National Park. However, this species is not considered to be adequately conserved within conservation reserves in the region given that only 5 known locations of the species exist within the area (DEC 2007).

Habitat requirements

Sophora fraseri is usually found in moist situations, often near rainforest (DEC 2005–).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC (DEC 2005–) lists the follow threats to the species: loss of habitat through clearing for agriculture and development; timber harvesting activities; weed infestation, especially by Lantana; inappropriate fire regimes: regeneration from seed is stimulated by fire, but plants may be killed by fire before producing seed; and, risk of local extinction because populations are small.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade

that may impact on potential habitat for *Sophora fraseri* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Sophora fraseri.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Sophora fraseri*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- *Lantana camara* - *Sophora fraseri* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Sophora fraseri.* The DECC (DEC 2005–) lists recovery actions for this species. Those relevant to the project include

- Protect areas of habitat from frequent fire;
- Control weeds in and near habitat; and,
- Protect known and potential habitat from clearing and development.

The proposed upgrade is not likely to interfere with the recovery of *Sophora fraseri*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In total, 14 locations of the species occur in NSW, all of which are located in northern NSW within an area bounded by Ballina, west to Kyogle and north to Tweed Heads (DEC 2007, NSW Government 2007).

There is one known record of the species within a 10 km radius of the study area, occurring approximately 8 km to the south-west of the subject site.

Locations relative to limits of distribution

The species has been recorded north from the Casino district in north-east NSW, where it is very rare. Also in south-east Queensland where it is widespread but not common (DEC 2005–). The study area is at the south eastern limit of known distribution of the species (DEC 2007).

Habitat (within study area)

Sophora fraseri was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Sophora fraseri*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Sophora fraseri* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species

were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival for the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Sophora fraseri* would be placed at risk of extinction by the proposed upgrade.

Syzygium hodgkinsoniae

Description

Syzygium hodgkinsoniae is a small tree to about 11 m tall. Its paired leaves are oval shaped or slightly elongated, 8 - 15 cm long, with a short blunt point at the tips. The flowers are off-white, fluffy and honey scented, about 25 mm in diameter, and are held in clusters at the ends of stems. The fruit are 4 cm in diameter, round and bright red. A thin layer of flesh, with a distinctive smell like that of an ashtray, encloses a single large seed (DEC 2005).

Conservation status

Syzygium hodgkinsoniae is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VC-, indicating:

3 = A geographic range of >100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded in a number of conservation reserves in the region, including Limpinwood Nature Reserve, Mount Warning National Park, Numinbah Nature Reserve, Mooball National Park, Whian Whian State Conservation Area and Mount Jerusalem National Park (DEC 2007). However, this species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Syzygium hodgkinsoniae is usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils (DEC 2005). The species is also known to occur in remnant and regrowth rainforest (DEC 2005).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC lists the follow threats to the species (DEC 2005): clearing and fragmentation of habitat for development, agriculture, road-works and powerlines; weed infestation and general degradation of rainforest habitat; grazing and trampling of seedlings and saplings by domestic stock; roadside slashing and mowing; and, illegal collection for horticulture.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Syzygium hodgkinsoniae* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Syzygium hodgkinsoniae.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Syzygium hodgkinsoniae*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

To date, no Recovery Plan has been prepared for *Syzygium hodgkinsoniae.* The DECC (DEC 2005) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Identify roadside trees and protect them during road-works – the species was not recorded within the Subject Site;
- Remove weeds in rainforest environments – weed control works will be included as part of the Vegetation Management Plan;
- Protect areas of suitable rainforest habitat from clearing or development – potential habitat for the species will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Syzygium hodgkinsoniae*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

In total, 188 locations of the species occur in NSW (DEC 2007). The species appears to be restricted to coastal areas north of Ballina to the Queensland border (DEC 2007). Additional records on the Bionet Database (NSW Government 2007) show records extending south of Ballina to Broadwater.

There are 55 known records of this species within a 10 km radius of the study area, the closest of which occurs approximately 700 m to the west of the subject site.

Locations relative to limits of distribution

The species has a restricted range from the Richmond River in north-east NSW to Gympie in Queensland (DEC 2005). It is known to be locally common in some parts of its range, but otherwise sparsely distributed (DEC 2005). The study area is near the southern limit of known distribution of the species.

Habitat (within study area)

Syzygium hodgkinsoniae was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Syzygium hodgkinsoniae*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the

Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Syzygium hodgkinsoniae* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Syzygium hodgkinsoniae* would be placed at risk of extinction by the proposed upgrade.

Syzygium moorei

Description

Syzygium moorei is a tree growing up to 40 m tall, with dense dark foliage. The bark is red-brown, light grey or pinkish grey with soft papery scales. Its paired leaves are thick, oval-shaped or slightly elongated, 8 - 20 cm long and usually rounded at the tips. Flowers are showy, pink to red, fluffy, and clustered directly on older leafless branches and the trunk of the tree. The white fleshy fruits are edible, but rather tasteless. They have a diameter of up to 6 cm and enclose a single seed (DEC 2005q).

Conservation status

Syzygium moorei is listed as Vulnerable on both the TSC Act and the EPBC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 2VCi, indicating:

2 = A geographic range of <100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

i = Less than 1000 plants are known to occur within a conservation reserve

Syzygium moorei is known to occur in several conservation reserves in the area, including Numinbah Nature Reserve, Cudgen Nature Reserve, Billinudgel Nature Reserve, Washpool National Park and Brunswick Heads Nature Reserve (DEC 2007). Despite this, the species is not considered to be adequately represented in conservation reserves.

Habitat requirements

The species occurs within subtropical and riverine rainforest at low altitude (DEC 2005q). *Syzygium moorei* often occurs as isolated remnant paddock trees (DEC 2005q).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC lists the follow threats to this species (DEC 2005q): clearing and fragmentation of habitat for development, agriculture and road-works; weed infestation and general degradation of rainforest habitats; grazing and trampling of seedlings and saplings by domestic stock; and, illegal collection for horticulture.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Syzygium moorei* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Syzygium moorei.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Syzygium moorei*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.

To date, no Recovery Plan has been prepared for *Syzygium moorei.* The DECC (DEC 2005q) has identified a number of priority actions to help the recovery of this species. Those relevant to the proposed upgrade include:

- Prevent fire from entering remnants containing *S. moorei – the proposed upgrade is not likely to alter the fire frequency within the local area.*
- Prevent further clearing and fragmentation of *S. moorei* habitat – habitat for

the species will be cleared as part of the proposed upgrade.

- Control weeds in remnants containing *S. moorei* – weed control works will be detailed within the Vegetation Management Plan.

The proposed upgrade is not likely to interfere with the recovery of the species, given the numerous recordings of the species over 776 ha of similar habitat mapped as occurring in the local area (NPWS 1997b).

Local and regional abundance

A total of 293 known records of the species occur in NSW, to the north of Ballina in the Byron and Tweed areas. There are also scattered records of the species in the Ballina area and an isolated record of the species further west in the Clarence Valley area (DEC 2007).

There are 130 known records of the species within a 10 km radius of the study area, some of which occur in the study area, as described below.

Locations relative to limits of distribution

The species is found in the Richmond, Tweed and Brunswick River valleys in north-east NSW and with limited occurrence in south-east Queensland (DEC 2005q). The study area is near the south-eastern limit of distribution for the species.

Habitat (within study area)

There are six records of this species in the study area including (Figure 2):

- One record in Patch 1, supporting 15 scattered remnant mature trees. These trees will be indirectly impacted;
- One record within Patch 5, occurring in a patch of Lowland Rainforest along the existing Pacific Highway; This tree will be directly impacted;
- One specimen to the north of patch 7 on the edge of the study area. This tree would be indirectly impacted.
- One record within the Patch 10, which is planted within a revegetated patch of Lowland Rainforest. This record would be indirectly impacted; and,
- One record to the south-west of Patch 14, occurring as a planted tree in a garden landscape. This tree will be indirectly impacted.

Habitat within the study area is within Lowland Rainforest, which occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and

species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), therefore the proposed upgrade is not likely to interfere with critical habitat for the species.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

One known record of the species will be impacted by the proposed upgrade, with an additional four records being indirectly impacted. The proposed upgrade would result in the removal of approximately 2.0 ha of known and potential habitat for *Syzygium moorei*, with a further 3.6 ha of known and potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 294 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of known and potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through displacement of individuals, disturbance to the soil seed bank, disrupting recruitment and habitat modification. However, impacts on the lifecycle of the local population of the species given the numerous recordings of the species are likely to be minor in the local area and the fact that only one known record would be directly impacted by the proposed upgrade.

Known and potential habitat for *Syzygium moorei* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any known or potential habitat for the species.

Given that only 0.3 % of known and potential habitat within the study area would be directly impacted by the proposed upgrade and the fact that only one known record of the species will be directly impacted, it is considered unlikely that a viable local population of *Syzygium moorei* would be placed at risk of extinction by the proposed upgrade.

Syzygium paniculatum

Description

Syzygium paniculatum is a small to medium sized rainforest tree that grows to 8 m tall. The bark is flaky and the leaves are shiny, dark-green above and paler underneath. Leaves can be up to 10 cm long. Plants produce white flower-clusters at the end of each branch, between November and February. The petals are small and are accompanied by prominent long stamens. The deep magenta fruits, which may be spherical or egg-shaped, mature in May, and contain a single seed (DEC 2005„).

Conservation status

Syzygium paniculatum is listed as Vulnerable on both the TSC Act and the EPBC Act. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3VCi, indicating:

3 = A geographic range of >100 km

V = Vulnerable species

C = Reserved, with a least one population in a national park

i = Less than 1000 plants are known to occur within a conservation reserve

Syzygium paniculatum is not known to occur in any conservation reserves in the local area, however there are many records from conservation reserves to the south where the bulk of the records occur, including: Myall Lakes National Park, Saltwater National Park and Wyrrabalong National Park (DEC 2007). The species is not considered to be adequately represented in conservation reserves in the region.

Habitat requirements

On the south coast, *Syzygium paniculatum* occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast *Syzygium paniculatum* occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DEC 2005„).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC lists the follow threats to this species (DEC 2005„): loss of habitat through clearing for residential development; grazing and trampling of habitat by grazing stock; weeds, particularly Lantana, are invading the species' habitat; and, frequent fire.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Syzygium paniculatum* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Syzygium paniculatum.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Syzygium paniculatum*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. However, most remnants that provide habitat for this species in the study area are already impacted by weed invasion due to their small and fragmented nature. Weed control works should be detailed in the Vegetation Management Plan.
- Herbivory and environmental degradation caused by feral deer - Syzygium paniculatum is listed as a species that is threatened by this KTP. The proposed upgrade is not likely to increase the threat of herbivory and environmental degradation caused by feral deer.
- *Lantana camara* - *Syzygium paniculatum* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared for *Syzygium paniculatum.* The DECC (DEC 2005„) has identified a number of priority actions to help the recovery of this species. Those relevant to the proposed upgrade include:

- Protect known sites from fire; ensure that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat – the proposed upgrade is not likely to alter the fire frequency within the local area.
- Undertake weed control, but avoid spraying weeds close to *Syzygium paniculatum* to ensure they are not affected by poison – weed control works will be specified in the Vegetation Management Plan.
- Protect known habitat areas from clearing and disturbance – potential habitat for this species will be cleared by the proposed upgrade.

The proposed upgrade is not likely to impact on the recovery of the species, as the species is not known to occur in the study area and no known areas of habitat would

be impacted.

Local and regional abundance

A total of 146 known records of the species occur in NSW, the majority of which occur between Nowra and Bulahdelah (DEC 2007). There are only two records of the species in the local area, occurring to the west of Ballina near Alstonville and further west in the Kyogle area (DEC 2007).

Two records of the species exist within a 10 km radius of the study area.

Locations relative to limits of distribution

The species is found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest (DEC 2005„). The study area is north of the known distribution for the species.

Habitat (within study area)

The species has not been recorded within the study area.Potential habitat within the study area is within Lowland Rainforest.

Potential habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species (DEC 2004c), therefore the proposed upgrade is not likely to interfere with critical habitat for the species.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Syzygium paniculatum*, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of potential habitat to be removed as part of the proposed upgrade equates to 0.3 % of similar vegetation that exists in the Locality (based on 294 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 1.3 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation

of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Syzygium paniculatum* that will be impacted as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to be important to the long term survival of the species.

Given that only 0.3% of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Syzygium paniculatum* would be placed at risk of extinction by the proposed upgrade.

Tinospora tinosporoides

Description

Tinospora tinosporoides is a tall woody climber. The triangular leaves with broadly notched bases give the plant its common name (Arrow-head Vine), though leaf-shape varies through to oval. The leaves are thick, stiff, glossy, and are mostly 8 – 13 cm long. The leaf stalk is 5 – 12 cm long, with a swelling at each end, and a characteristic twist or angle at its junction with the stem. Male and female flowers are borne on separate plants, and are small and inconspicuous in long branched clusters. The fleshy fruits are produced in groups of three (DEC 2005e).

Conservation status

Tinospora tinosporoides is listed as Vulnerable on both the TSC and EPBC Acts. The species is also listed as a ROTAP (Briggs and Leigh 1996), with a conservation rating of 3RC-, indicating:

3 = A geographic range of >100 km

R = Rare species

C = Reserved, with a least one population in a national park

- = Reserved population size is not accurately known

The species has been recorded in a number of conservation reserves in the region, including Bongil Bongil National Park, Washpool National Park, Toonumbar National Park and Mount Warning National Park (DEC 2007). Despite this,

Tinospora tinosporoides is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Tinospora tinosporoides is found in wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils (DEC 2005e).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC lists the follow threats to this species (DEC 2005e): clearing and fragmentation of habitat for development, agriculture, and roads; risk of local extinction because populations are small at some locations; grazing and trampling by domestic stock; fire; invasion of habitat by introduced weeds; and, accidental damage to plants when cutting introduced vines during bush regeneration.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for *Tinospora tinosporoides* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing native vegetation that is potential habitat for *Tinospora tinosporoides.*
- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for*Tinospora tinosporoides*.
- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.
- Exotic vines and Scramblers – *Tinospora tinosporoides* is specifically listed as a species impacted by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects.
- *Lantana camara - Tinospora tinosporoides* is listed as a species that is threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly

disturbed and impacted by edge effects.

To date, no Recovery Plan has been prepared *Tinospora tinosporoides.* The DECC (DEC 2005e) has identified the a number of priority actions to help the recovery of this species. Those relevant to the proposed upgrade include:

- Protect rainforest from fire – the proposed upgrade is not likely to alter the fire frequency of the local area;
- Control weeds in and near known habitat, taking particular care when other species of vine require cutting – weed control works should be detailed in a Vegetation Management Plan; and,
- Protect areas of habitat from clearing or development – potential habitat for the species will be cleared as part of the proposed works.

One individual of *Tinospora tinosporoides* would be directly impacted by the proposed upgrade. This plant occurs within thin strip of Lowland Rainforest adjoining the Pacific Highway. The impacts to this plant are not likely to interfere with the recovery of the species.

Local and regional abundance

In total, 109 locations of the species occur in northern NSW, with the majority of records occurring in the Byron/Ballina area (DEC 2007). Scattered records of the species also occur as far south as Coffs Harbour and as far west as the Clarence Valley (DEC 2007).

There are 82 known locations of the species within a 10 km radius of the study area.

Locations relative to limits of distribution

The species occurs north from the Richmond River in north-east NSW, where it is locally common in some parts of its range. *Tinospora tinosporoides* is also recorded from a single location in south-east Queensland (DEC 2005e). Two outlier occurrences of the species are located in the Coffs Harbour and Clarence Valley areas (DEC 2007). The study area is not considered to be at the limit of the known distribution for the species.

Habitat (within study area)

This species has previously been recorded within the study area (Figure 2), with:

- Two recordings in Patch 6, in a patch of Lowland Rainforest. One of these records would be directly impacted; and,

- One record in Patch 14, in a patch of Lowland Rainforest, which would be indirectly impacted.

Within the study area, potential habitat for this species is also considered to be within Lowland Rainforest and patches of Camphor Laurel.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

One known record of *Tinospora tinosporoides* would be directly impacted by the proposed upgrade. Known and potential habitat for *Tinospora tinosporoides* occurs in Lowland Rainforest and Camphor Laurel in the study area.The removal of 7.7 ha of vegetation that is potential habitat for *Tinospora tinosporoides,* with a further 20.8 ha that is within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy for the species given the density of records in the local area and the fact that there is approximately 776 ha of moist forest (including general rainforest) as mapped by NPWS (NPWS 1997b) and a large area of Camphor Laurel occurring in the local area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and modification of habitat in the study area. Disruption to the lifecycle of two individuals of the species (including indirectly impacted records) is unlikely to impact on the long-term viability of the species in the local area, given the number of records of the species in the local area.

Potential habitat for *Tinospora tinosporoides* that would be directly impacted as part of the proposed upgrade consists of approximately six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any habitat for the species. Further, the proposed upgrade follows the existing Pacific Highway for the majority of its length, reducing potential for further fragmentation

of habitats in the local area.

Given that only one known record of the species will be directly impacted, the fact that the proposed upgrade is not likely to fragment an existing population, and potential habitat to be impacted is in poor condition and not likely to be important to the long term survival of the species, it is considered unlikely that a viable local population of *Tinospora tinosporoides* would be placed at risk of extinction by the proposed upgrade.

Xylosma terrae-reginae

Description

Xylosma terrae-reginae is a tall shrub or small tree growing to 15 m tall. Its trunk is crooked with low branches, and has smooth grey bark with fine vertical lines. The leaves are oval-shaped, 8 – 15 cm long, tapering to a short point at the tips. The leaf is glossy, dark green above and paler below. Flowers are small and white and held in clusters, and are followed by round red berries, 8 – 10 mm in diameter in clusters of up to four. Each fruit contains 1 - 4 seeds (DEC 2005§).

Conservation status

Xylosma terrae-reginae is listed as Endangered on the TSC Act.

Six populations of the species have been recorded since 1980, of which only two populations occur in conservation reserves, at Broken Head and Brunswick Heads Nature Reserves (NSW Scientific Committee 2000c). This species is not considered to be adequately conserved within conservation reserves in the region.

Habitat requirements

Xylosma terrae-reginae is usually found in littoral and subtropical rainforest on coastal sands or soils derived from metasediments (DEC 2005§).

Key Threatening Processes, Recovery and Threat Abatement Plans

The DECC lists the follow threats to the species (DEC 2005§): clearing and fragmentation of habitat for coastal development, agriculture and roadworks; infestation of habitat by weeds; trampling of seedlings and saplings by visitors; fire; and, risk of local extinction due to small population size.

Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade and that may impact on potential habitat for *Xylosma terrae-reginae* include:

- Clearing of native vegetation – the proposed upgrade would involve clearing

native vegetation that is potential habitat for *Xylosma terrae-reginae*.

- Ecological consequences of high frequency fires – the proposed upgrade is unlikely to alter the frequency of fires within areas that contain potential habitat for *Xylosma terrae-reginae*.

- Invasion of native plant communities by exotic perennial grasses – it is possible that the proposed upgrade would increase the potential for invasion by exotic grasses along the edges of the proposed road. Most remnants that provide habitat for the species in the study area are already impacted by weed invasion due to their small, fragmented nature and proximity to development. Weed control works should be detailed in the Vegetation Management Plan.

To date, no Recovery Plan has been prepared for *Xylosma terrae-reginae.* The DECC (DEC 2005§) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Control fire around the edges of rainforest patches – the proposed upgrade is not likely to alter the fire frequency within the local area.

- Control introduced weeds in littoral and subtropical rainforest areas – Weed control works will be specified in the Vegetation Management Plan.

- Prevent ornamental plants and weeds from escaping from gardens into nearby rainforest – landscaping adjoining areas of native vegetation will use local native species, grown from local provenance, only.

- Protect areas of littoral and subtropical rainforest from clearing or development - potential habitat for the species will be cleared by the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Xylosma terrae-reginae*, as the proposed upgrade does not impact any areas of known habitat.

Local and regional abundance

Six populations of the species have been recorded since 1980 (NSW Scientific Committee 2000c). Individual populations are small and the best estimate of the total population in New South Wales is less than 250 mature individuals (NSW Scientific Committee 2000c).

There are 10 known records of this species within a 10 km radius of the study area.

Locations relative to limits of distribution

The species occurs in the Richmond River district in north-east NSW, north to the Maryborough region in Queensland (DEC 2005§). The study area is near the southern limit of known distribution for the species.

Habitat (within study area)

Xylosma terrae-reginae was not detected during field surveys within the study area. Within the study area, potential habitat for this species is considered to be within Lowland Rainforest.

Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for this species, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Xylosma terrae-reginae,* with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The lifecycle of the species may be impacted through disturbance to the soil seed bank, disrupting recruitment and habitat modification. However this is unlikely as the species was not recorded in the study area.

Potential habitat for *Xylosma terrae-reginae* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape. The proposed upgrade would not result in the isolation of any potential habitat for the species. Since no individuals of this species were recorded in the study area, the potential habitat to be impacted is not likely to

be important to the long term survival of the species.

Given that only 0.3 % of potential habitat within the study area for this species would be directly impacted by the proposed upgrade and the fact that the species was not recorded during field surveys, it is considered unlikely that a viable local population of *Xylosma terrae-reginae* would be placed at risk of extinction by the proposed upgrade.

Endangered Ecological Communities

An impact assessment is required for one Endangered Ecological Communities listed on the TSC Act: Lowland Rainforest. The impact of the proposed upgrade on this EEC is detailed below.

Lowland Rainforest of the NSW North Coast and Sydney Basin bioregions

Description

Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes, give the canopy an irregular appearance (NSW Scientific Committee 2006c). The trees are taxonomically diverse at the genus and family levels, and some may have buttressed roots. A range of plant growth forms are present in Lowland Rainforest, including palms, vines and vascular epiphytes. Scattered eucalypt emergents (e.g. *Eucalyptus grandis, E. saligna*) may occasionally be present (NSW Scientific Committee 2006c).

In disturbed stands of this community the canopy continuity may be broken, or the canopy may be smothered by exotic vines (NSW Scientific Committee 2006c).

Conservation status

Lowland Rainforest of the NSW North Coast and Sydney Basin bioregions (LR) is listed as Endangered on the TSC Act (NSW Scientific Committee 2006c).

Small areas of LR are contained within existing conservation reserves (including components of the Central Eastern Rainforest Reserves of Australia World Heritage listing). However, not all Lowland Rainforest suballiances occur in conservation reserves and many small stands, important for connectivity and maintenance of landscape-scale ecological processes, remain outside conservation reserves (NSW Scientific Committee 2006c).

Within the study area, LR largely occurs as fragmented patches within a rural landscape. It is unlikely that this plant community is adequately conserved in the region.

Habitat requirements

Lowland Rainforest is associated with a range of high-nutrient geological substrates, notably basalts and fine-grained sedimentary rocks, on coastal plains and plateaux, footslopes and foothills (NSW Scientific Committee 2006c).

In the north of its range, Lowland Rainforest is found up to 600 m above sea level, but in the Sydney Basin bioregion it is limited to elevations below 350 m (NSW Scientific Committee 2006c).

Key Threatening Processes, Recovery and Threat Abatement Plans

Common threats include grazing by livestock; potential impacts of anthropogenic (human induced) climate change; impacts associated with human visitation (including soil compaction, possible spread of pathogens, clearing of understorey and inappropriate collection of plant species); and, collection and trade of some rainforest invertebrates (NSW Scientific Committee 2006c). Collectively these processes may result in degradation of Lowland Rainforest habitat, and hence a large reduction in ecological function of the community (NSW Scientific Committee 2006c).

The following Key Threatening Processes listed under the TSC Act may threaten LR:

- Clearing of native vegetation – the proposed upgrade would result in the direct removal of approximately 2.0 ha of LR;
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands – the proposed upgrade is not likely to alter the hydrology of the area.
- Invasion of native plant communities by exotic perennial grasses – The proposed upgrade may increase the threat of weed invasion. However, weed control works should be detailed in a Vegetation Management Plan.
- Predation, habitat destruction, competition and disease transmission by feral pigs – the proposed upgrade is not likely to increase the threat of feral pigs.
- Anthropogenic climate change – the proposed upgrade may indirectly increase the threat of anthropogenic climate change, as approximately 9.1 ha of native vegetation would be required to be cleared (releasing CO_2 into the atmosphere). The proposed upgrade would not result in a further increase in

the use of fossil fuels. The overall increase in the threat of anthropogenic climate change is likely to be relatively minor.

- High frequency fire – the proposed upgrade is not likely to alter fire regimes of the Locality.

- Exotic vines and Scramblers – Lowland Rainforest is specifically listed as an ecological community impacted by this KTP (NSW Scientific Committee 2006a). The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the impacted patches of vegetation are already highly degraded, small and fragmented and, as such, impacted by edge effects. Further weed control works should be detailed in a Vegetation Management Plan.

- *Lantana camara* – Lowland Rainforest is listed as an ecological community threatened by this KTP (NSW Scientific Committee 2006b). The proposed upgrade is not likely to increase the threat of *Lantana camara* in the local area, as the patches of vegetation within the subject site are already highly disturbed and impacted by edge effects. Further weed control works should be detailed in a Vegetation Management Plan.

To date, there is no Recovery Plan or Threat Abatement Plan for LR.

Local and regional abundance

Since European settlement Lowland Rainforest has undergone a large reduction in geographic distribution due to clearing (NSW Scientific Committee 2006c). The Big Scrub lowland rainforest near Lismore, originally estimated to cover 75 000 ha, had been reduced to only 300 ha (0.07 %) since European settlement. Other districts as far south as Ourimbah have suffered similar losses of Lowland Rainforest (NSW Scientific Committee 2006c).

Lowland Rainforest remains only as small heavily disturbed patches on the lower escarpment slopes and floodplains in the local area. The total area of Lowland Rainforest (including disturbed areas) within the Locality is approximately 776 ha.

Locations relative to limits of distribution

There are strong latitudinal trends in the composition of Lowland Rainforest, with species diversity and structural complexity declining from north to south (NSW Scientific Committee 2006c). The Hawkesbury River notionally marks the southern limit of Lowland Rainforest in the NSW North Coast and Sydney Basin bioregions. The study area is considered to be near the northern limit of distribution for the ecological community.

Habitat (within study area)

Within the study area, Lowland Rainforest occurs as scattered patches in largely cleared agricultural land on the lower escarpment slopes and floodplains (Figure 4). Lowland Rainforest was considered to be in moderate to poor condition in the study area, with a highly modified structure and species composition due to weed invasion, surrounding land uses and extensive clearing. Some patches retain a relatively high native species diversity and, as such, were considered in be in moderate condition.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest would be impacted by the proposed upgrade, with an additional 3.6 ha indirectly impacted. The proposed upgrade would result in direct impacts to 0.3 % of Lowland Rainforest in the Locality (based on 776 ha of rainforest within 10 km radius of the study area (NPWS 1997b)).

Considering the poor quality of this community within the study area and the small area to be cleared by the proposed upgrade, indirect impacts are considered to be negligible. No additional fragmentation of this community would result from the proposed upgrade and therefore increased edge effects are unlikely.

The proposed upgrade is not likely to significantly impact the long-term viability or rate of extinct of Lowland Rainforest.

Fauna

Impact Assessments are required for 38 threatened species listed on the TSC Act: Pouched Frog, Green and Golden Bell Frog, Bush-hen, Magpie Goose, Barred Cuckoo-shrike, Coxen's Fig-Parrot, Black-necked Stork, Red Goshawk, Brolga, Comb-crested Jacana, Black Bittern, Square-tailed Kite, White-eared Monarch, Marbled Frogmouth, Wompoo Fruit-dove, Rose-crowned Fruit-dove, Superb Fruit-dove, Australian Painted Snipe, Freckled Duck, Red-backed Button-quail, Grass Owl, Sooty Owl, Masked Owl, Large-eared Pied Bat, Spotted-tailed Quoll, Little Bent-wing Bat, Eastern Bent-wing Bat, Large-footed Myotis, Eastern Long-eared Bat, Koala, Common Planigale, Long-nosed Potoroo, Black Flying-fox, Grey-headed Flying Fox, Greater Broad-nosed Bat, Common Blossom-bat, Mitchell's Rainforest Snail and Three-toed Snake-tooth Skink. The species profiles below detail the impacts of the proposed upgrade on these animal species.

Unless otherwise stated the information contained in the following species profiles has been derived from the NSW Government's Bionet database and DECC's

Threatened Species profiles and/or Environmental Impact Assessment Guidelines for each species.

Australian Painted snipe *Rostratula benghalensis australis*

Description

The Australian Painted Snipe *Rostratula benghalensis* is a cosmopolitan freshwater wader that occurs in Africa, the Middle East and Asia, as well as Australia. The Australian population was originally recognised as the subspecies *Rostratula benghalensis australis*; however, a recent study suggests that the Australian population represents a new species, referred to as *Rostratula australis* (Lane and Rogers 2000). Little is known of the population's movements; it is possible that it is migratory (within Australia or extralimitally) or nomadic (Marchant and Higgins 1993b).

Conservation status

The Australian Painted Snipe is listed as Endangered on the TSC Act, under the name "Painted Snipe (Australian subspecies)". It is unclear whether or not the species is adequately represented within conservation reserves in the Region. It has not been recorded in conservation reserves in the Locality.

Potential foraging habitat for the Australian Painted Snipe occurs within the study area around small swamps, dams and marshy areas. These areas are fragmented and occur along tributaries, disturbed agricultural land and alongside existing roads. Typically, these habitats are modified and degraded within the study area.There are no SEPP 14 wetlands within the study area.

Habitat requirements

The Australian Painted Snipe occurs in both coastal and inland shallow freshwater wetlands. Preferring fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber, it can also inhabit brackish wetlands. Grass tussocks, reeds or rushes are required for nesting habitat; shores of channels are also sometimes used for nesting. Breeding can occur near shallow wetlands, ephemeral or permanent waterbodies, or inundated grasslands/paddocks. Foraging takes place on mudflats or vegetated wetlands and has also been recorded under clumps of tea trees (Marchant and Higgins 1993b). The species' diet includes vegetation, seeds, and terrestrial invertebrates as well as freshwater/estuarine invertebrates gleaned from water or mudflats (Marchant and Higgins 1993b).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act. The

proposed upgrade would involve the operation of the KTP 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands'. This would involve the crossing of tributaries, streams and creeks (including Emigrant Creek and Byron Creek) and disturbance to surrounding vegetation; impacts on the waterways are expected to be minimised by proposed bridging of watercourses.

Further threats to the species include:

- Drainage of breeding sites in wetlands;
- Reduced water quality from siltation and pollution;
- Predation by foxes and feral cats;
- Use of herbicides, insecticides and other chemicals near wetlands; and,
- Grazing and associated frequent burning of wetlands.

To date, there is no Recovery Plan or Threat Abatement Plan for the Australian Painted Snipe.

DECC species recovery actions relevant to the proposed upgrade include:

- Protect wetlands and watercourses from pollution.
- Protect wetlands and associated marshy areas from clearing or disturbance.

Local and Regional Abundance

There are few scattered records of the Australian Painted Snipe from coastal and inland wetland locations throughout NSW (DECC Atlas of NSW Wildlife; Bionet). The species has been recorded once in the Locality, southeast of the study area towards the mouth of the Richmond River.

Locations relative to limits of distribution

The study area is not at the limit of distribution of the Australian Painted Snipe, which has a patchy distribution throughout Australia (Marchant and Higgins 1993b).

Habitat (within study area)

Potential habitat for the Australian Painted Snipe occurs within the study area around small swamps, dams, inundated grasslands and marshy areas. These areas provide potential nesting, foraging and roosting habitat. This habitat is considered to be in moderate to poor condition, due to impacts from rural, agricultural and residential development and clearing.

To date, critical habitat has not been declared for this species (DEC 2004c).

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would require the clearing of some small, fragmented and degraded areas of potential habitat for the Australian Painted Snipe. This potential habitat within the study area is subject to existing impacts from agricultural and residential use and is of poor to moderate quality. Similar habitat types are common along rivers, creeks and their tributaries within the Locality. None of the potential habitat within the study area contains mudflats.

Potential indirect impacts of the proposed upgrade include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major water crossings will minimise indirect impacts.

Overall, potential habitat for the Australian Painted Snipe within the study area is limited and of relatively poor quality. Potential habitat within the study area represents only a small proportion of the potential habitat available within the Locality (some of which includes mudflats and wetlands). Given this, together with the sparse records of the species within the Locality, it is considered that the impact of the proposed upgrade on the Australian Painted Snipe would be minor.

Barred Cuckoo-shrike *Coracina lineata*

Description

The Barred Cuckoo-shrike is a medium, dark grey cuckoo-shrike with yellow eyes and heavy bars on the belly. It feeds on small, native fruits such as figs, and insects on the outer foliage of trees.

Conservation status

The Barred Cuckoo-shrike is listed as Vulnerable on the TSC Act.

This species has been recorded north-west of the study area in Night Cap National Park and Mount Jerusalem National Park. Farther north-west, it has been recorded in conservation reserves in the Great Dividing Range. South of the study area, it has been recorded in the southern end of Bundjalung National Park. The distribution of this species is wide in northern NSW, but relatively few records are from conservation reserves. The species is probably inadequately represented in

conservation reserves.

Potential habitat for this species is present in the study area in Lowland Rainforest. The patches of this vegetation type in the study area are considered to be in poor-moderate condition, as they are small and highly fragmented.

Habitat requirements

The Barred Cuckoo-shrike inhabits mainly rainforests and tall, closed, subtropical forest in north-east NSW (Higgins *et al.* 2006). They occur less frequently in wet sclerophyll forests, and are often seen in isolated fruiting trees, especially figs (Higgins *et al.* 2006). They are also seen in swamp forests and timber alongside watercourses (NPWS 2005). They are active birds, usually seen in pairs or small flocks foraging among foliage of trees for insects and fruit (NPWS 2005). It is largely resident, although some movements to exploit fruiting trees are described as nomadic (Higgins *et al.* 2006).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes as listed in the TSC Act: 'Clearing of native vegetation'. This involves the removal of feed trees, shelter and nesting habitat.

To date, no recovery or Threat Abatement Plan has been prepared for this species. The DECC lists the following objectives relevant to the proposed upgrade to help the recovery of this species:

- Retain areas of native forest;
- Retain forest corridors particularly along roads and watercourses;
- Retain individual native fruit-bearing trees as feed trees; and,
- Initiate and support rainforest regeneration.

Local and regional abundance

The Barred Cuckoo-shrike is considered uncommon throughout its range and rare in northern NSW (Slater *et al.* 2003). Records, both locally and in the broader region, are widespread, but relatively sparse. The species was not recorded in the study area or within the 10 km search area.

Location relative to limits of distribution

In Australia, the Barred Cuckoo-shrike occurs at scattered sites in QLD from Cape York south along the coast to the NSW border (Higgins *et al.* 2006). In NSW, the species is mostly confined to the Northern Rivers and Mid-North Coast regions,

south to Manning River (Higgins *et al.* 2006). There are a few records of vagrants from as far south as Sydney (Higgins *et al.* 2006). The study area is not considered to be at or close to the limits of known distribution for this species.

Habitat (within study area)

Potential habitat for this species exists in the study area in Lowland Rainforest. Patches of this plant community in the study area are considered to be of moderate quality due to previous disturbances and their fragmented nature. They are small patches within a landscape that is generally highly disturbed.

To date, critical habitat has not been declared for this species; therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest, potential foraging and roosting habitat for the species, would be removed, with a further 3.6 ha affected indirectly. This represents less than 1% of moist forest and rainforest (including disturbed habitat) mapped by NPWs (1997b) as occurring in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would fragment potential habitat for the Barred Cuckoo-shrike further. It is considered unlikely that a viable local population of the Barred-cuckoo Shrike would be placed at risk of extinction by the proposed upgrade.

Black Bittern *Ixobrychus flavicollis*

Description

The Black Bittern is a dark heron with a characteristic booming call. It is found in India, south-east Asia and on numerous islands, as well as in Australia. The Australian subspecies is known as *Ixobrychus flavicollis australis* (Marchant and Higgins 1990). Little is known of their seasonal movements, although most populations are thought to be sedentary (Marchant and Higgins 1990).

Conservation status

The Black Bittern is listed as Vulnerable on the TSC Act.

The extent to which this species is represented in conservation reserves is largely unknown, although records are present nearby in Boatharbour Nature Reserve and Nightcap National Park (DECC Atlas of NSW Wildlife). More surveys would be required to determine whether this species is adequately represented in conservation reserves within the region.

Within the study area, potential habitat for the species occurs in permanent water within flooded grassland, wet depressions (heath/sedgeland), drainage lines and Lowland Rainforest, particularly adjacent to permanent water bodies/courses. These plant communities provide potential roosting, nesting and foraging habitat. No SEPP 14 Wetlands occur within the study area.Potential habitat in the study area has already been highly disturbed by agriculture, clearing and roads, and is considered to be of low habitat quality.

Habitat requirements

The Black Bittern inhabits terrestrial and estuarine wetlands, predominantly within areas containing permanent water and dense vegetation. Potential foraging and roosting habitat may include permanent water within flooded grassland, forest, woodland, rainforest and mangroves. Within this habitat, the Black Bittern will roost in trees or amongst dense reeds. The diet of the Black Bittern includes frogs, reptiles, fish and invertebrates, both terrestrial and aquatic. Foraging mostly occurs at dusk or nocturnally (NPWS 1999b). Nests are built in leafy trees overhanging water in densely vegetated wetlands. During the breeding season from December to March, these otherwise solitary birds are found in pairs (Marchant and Higgins 1990).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP ‘Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands’. The alteration of the waterside habitat within the study area could reduce the quality of nesting, roosting and foraging habitat for the Black Bittern, although impacts on the natural flow regime of waterways are expected to be minimised through the bridging of larger water courses and use of sedimentation control measures.

To date, there is no Recovery Plan or Threat Abatement Plan for the Black Bittern (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

Local and regional abundance

On a state level, records of the Black Bittern are mainly confined to within about 100 km of the coast, although some records are present from inland NSW, presumably from wetland/river systems (NPWS, Bionet).

The Black Bittern has been recorded at least 10 times within the Locality to both the north and south of the study area.

Locations relative to limits of distribution

The study area is not at the limits of distribution of the Black Bittern, which occurs in all states except South Australia and Tasmania (Marchant and Higgins 1990).

Habitat (within study area)

Potential habitat for the Black Bittern within the study area occurs in permanent water within flooded grassland, revegetation and Lowland Rainforest, particularly where adjacent to permanent water. These plant communities provide potential nesting, foraging and roosting habitat. The patches of vegetation within the study area are considered to be in moderate to poor condition, due to current impacts from agricultural and residential use and clearing.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail the clearing of potential foraging, roosting and breeding habitat, and possibly the alteration of the natural flow of waterways (KTP) for the Black Bittern. Potential habitat within the study area is considered to be of moderate to poor quality with better quality habitat for this species existing elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves). Potential habitat to be cleared represents less than 1% of potential habitat that occurs within the Locality. These habitat types are locally common along rivers, creeks and their tributaries within the Locality. SEPP 14 Wetlands are also present in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of larger watercourses will minimise indirect

impacts.

Given the small area of suboptimal habitat to be cleared, the large amount of potential wetland habitat within the surrounding area, the species' high mobility, and that fragmentation would not increase, it is considered unlikely that a viable local population of the Black Bittern would be placed at risk of extinction by the proposed upgrade.

Black-necked Stork *Ephippiorhynchus asiaticus*

Description

The Black-necked Stork is the only stork species in Australia. It stands about 1.3 m tall, and has a wingspan of around 2 m, with a massive, strong, black bill (Pizzey 1983). The head and neck are black with an iridescent green and purple gloss. Black panels are visible above and below the white wings. The tail is short and black, with the rest of the plumage white.

Conservation status

The Black-necked Stork is listed as Endangered on the TSC Act.

The majority of records of the Black-necked Stork in the Northern Rivers Region fall outside of conservation reserves. Reserves it has been recorded in include: Broadwater National Park, Bundjalong National Park and Bundjalong State Conservation Area. The species is unlikely to be adequately represented in conservation reserves in NSW.

Within the study area, potential foraging and roosting/nesting habitat for this species occurs on grassy floodplains, irrigated lands and in trees nearby water (e.g. along creeks, farm dams). No SEPP 14 Wetlands occur within the study area.Potential habitat is highly disturbed by agriculture, clearing and roads, and is considered to be of poor to moderate quality.

Habitat requirements

The Black-necked Stork is often found in swamps, mangroves and mudflats. It can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. It nests in live or dead trees usually near water (Pizzey 1983). The species forages in shallow water up to 0.5 m depth and predominantly feed on fish, reptiles and frogs (Garnett & Crowley 2000).

Key Threatening Processes and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade may involve the operation of the KTP 'Alteration to the

natural flow regimes of rivers, streams, floodplains & wetlands'. Impacts on the natural flow regime of the waterways are expected to be minimised by the bridging of larger water courses and through sedimentation control. The alteration of the waterside habitat within the study area is not likely to reduce the quality of nesting, roosting and foraging habitat for the Black-necked Stork.

Further threats to the species identified by the DECC include:

- Loss of wetland habitat through clearing and draining for flood mitigation, agriculture and residential development;
- Degradation of wetland habitats through pollution and salinisation; and,
- Modification of natural wetlands through changes in natural water flow regimes.

To date, there is no Recovery Plan or Threat Abatement Plan for the Black-necked Stork (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

The DECC has identified 8 priority actions and recovery measures to help recover this species in NSW. Those most relevant to the proposed upgrade include:

- Improve the protection of Black-necked Stork habitat by excluding stock, reducing grazing pressure and controlling weed species at important sites. Avoid placing powerlines over or near wetlands and/or nest sites;
- Restore natural hydrological regimes to freshwater wetlands. Maintain existing hydrological regimes. Do not fill or drain wetlands. Retain and protect native vegetation in and around wetlands. Restore degraded wetlands; and,
- Protect all vegetation within at least 200 metres of wetlands supporting the species.

Local and Regional Abundance

The species is widespread across coastal northern and eastern Australia, becoming increasingly uncommon further south into NSW, and rare south of Sydney where breeding has not been recorded (DECC). Some birds may move long distances and can be recorded well outside their normal range. The majority of the NSW population occurs in the Richmond and Clarence River valleys, Northern Rivers CMA.

The Black-necked Stork is a resident within the Locality, there being over 50 individuals recorded (39 records) within 10 km of the study area.It has been recorded five times within 3 km of the study area.The closest record of these

records borders within 500 m of the study area on the western fringe. The majority of records in the Locality are grouped along the Richmond River or scattered along the coast.

Locations relative to limits of distribution

The Black-necked Stork has been recorded as far inland as the Macquarie Marshes, although the numbers of individual birds have declined on the south coast and west of the Great Dividing Range. This species is considered to be a resident on the north coast. The study area is not at the limits of the species' distribution, although it falls within an important region of its distribution.

Habitat (within study area)

Potential habitat for the species occurs in the study area on grassy floodplains cleared for rural and agricultural use, irrigated lands and in trees nearby water (e.g. along creeks, farm dams). These plant communities provide potential roosting, nesting and foraging habitat. They will forage in waters up to 0.5 m deep (Marchant and Higgins, 1990). No SEPP 14 Wetlands occur within the study area .

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would result in clearing of potential foraging and roosting habitat for the Black-necked Stork. Better quality habitat for this species exists elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves) including SEPP 14 Wetlands in the Locality which do not occur in the study area.Potential habitat to be cleared represents less than 1% of potential habitat which occurs within the Locality. These habitat types are locally common on agricultural land and along rivers, creeks and their tributaries within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect impacts.

The Black-necked Stork prefers to nest in secluded places, often in tops of tall trees, usually in wetlands (Marchant and Higgins, 1990). No SEPP 14 Wetlands occur in the study area, and therefore, it is not likely to support core breeding habitat for the species. The proposed upgrade is unlikely to significantly affect the life-cycle of the species.

These birds are intolerant of disturbance, and encroachment of development may reduce local populations (Marchant and Higgins, 1990). However, the species is present in the study area and Locality and large numbers appear to be present in the region, suggesting that the current high level of disturbance does not preclude it from the region. Given that the species is highly mobile, fragmentation is unlikely to increase, only a small area of habitat is to be cleared and a large amount of potential habitat exists within the Locality, it is considered unlikely that a viable local population of the Black-necked Stork would be placed at risk of extinction by the proposed upgrade.

Black Flying Fox *Pteropus alecto*

Description

The Black Flying Fox is a large bat almost entirely black in colour, often with an incomplete rusty-red collar and a light frosting of silvery grey on the belly (Churchill 1998). The lower leg is unfurred.

Conservation status

The Black Flying Fox is listed as Vulnerable on the TSC Act.

The species is relatively uncommon in NSW, although it appears to be increasing in numbers, extending its range to the south (DECC). The species is not adequately represented in NSW Conservation Reserves, having only been recorded in the northern region's Bundjalung National Park, Broadwater National Park, Moore Park Nature Reserve and Boat Harbour Nature Reserve.

Habitat for this species exists in the study area in the Lowland Rainforest. This plant community in the study area is considered to be of low to moderate habitat quality due to its fragmented nature.

Habitat requirements

Black Flying Foxes form large communal day-time camps in remnants of coastal subtropical rainforest or swamp forest, often with Grey-headed Flying-foxes. They fly out at dusk to feed on rainforest fruits, as well as nectar and pollen from flowering eucalypts, paperbarks and banksias. When native foods are scarce, particularly during drought, they feed on fruit from orchards.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of feed trees and potential roosting

and nesting habitat for this species. However, no camps would be impacted by the proposed upgrade.

Further threats to the Black Flying Fox identified by the DECC include**:**

- Clearing and fragmentation of rainforest and swamp forest remnants used for roost sites, mostly as the result of urban development;
- Loss of forest areas used for feeding, particularly winter feeding areas, through agriculture, intensive forestry and urban development;
- Deliberate destruction and disturbance of flying-foxes including shooting of individuals and harassment and attempted re-location of camps near urban areas;
- Conversion of old-growth forests, woodlands and shrublands to young, even-aged stands as a result of intensive forestry and too-frequent burning; and,
- Invasion of habitat by introduced weeds.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified 16 priority actions and recovery options for the species. Those most relevant to the proposed upgrade include:

- Identify, protect and enhance forage and roosting habitat critical to survival across the species range;
- Assess the impacts of electrocution due to powerlines and entanglement in netting and barbed wire;
- Develop and implement strategies to reduce the impacts of electrocution and entanglement;
- Encourage residential development away from camps to avoid potential conflicts;
- Assist with removal of weeds from areas of known and potential habitat;
- Protect known flying-fox camps from clearing and fragmentation;
- Re-establish, rehabilitate and reconnect patches of lowland subtropical rainforest and swamp forest as potential roost sites and foraging habitat; and,
- Report records south of the Clarence River to the DECC.

Local and regional abundance

There are over 100 DECC records of the Black Flying Fox in NSW, only one of which is located outside of the Northern Rivers CMA. The species was observed in the study area during the current surveys and multiple (>10) records are located within 10 km of the study area, one being estimated at over 2,000 individuals. No camps were identified within the study area.Known Grey-headed Flying Fox camps that are known to be shared with Black Flying Foxes within the Region are located just north of Ballina near the North Creek Canal; east of the proposed road corridor within the Radburn property; in Currie Park, Lismore; and, Susan Island, Grafton. Further north of the study area, there are four camps regularly used by Black Flying Foxes and one camp used sporadically along the Gold Coast, Queensland (Roberts 2005).

Locations relative to limits of distribution

The Black Flying Fox is distributed along coastal and near-coastal areas across northern Australia, through eastern Queensland to the Bellinger River in northern NSW. Currently, the Northern Rivers Region is at the south-eastern limit of the species distribution. The most southern record of this species in NSW is within the Wingham Brush Nature Reserve, Greater Taree LGA (DECC Atlas of NSW Wildlife).

Habitat (within study area)

Breeding occurs in canopy trees in rainforest, coastal scrub, riparian or estuarine communities and with sufficient forage resources available within 40 km of the roost/breeding site (DECC). Patches of forest with canopy trees within 40 km of forage resource provide roosting habitat (DECC). No camps were identified within the Locality.

Within the study area, potential foraging habitat exists within Lowland Rainforest. In the study area, this plant community occurs as small, fragmented stands and is subject to disturbances from agricultural and residential development. This habitat was considered to be in moderate condition.

To date, critical habitat has not been declared for the Black Flying Fox; and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Potential foraging habitat for this species within the study area occurs in Lowland Rainforest. The proposed upgrade would remove approximately 2.0 ha and indirectly impact a further 3.6 ha (edge effects) of suitable habitat for the Black Flying Fox, which represents less than 1% of potential habitat in the

Locality. Potential habitat for the Black Flying Fox in the study area was considered to be in moderate to poor condition due to its small and fragmented nature. This species is highly mobile, enabling it to easily utilise habitat on either side of the proposed upgrade. It is unlikely the species would rely wholly on the habitat patches affected by the proposed upgrade. Therefore, it is considered unlikely that a viable local population of the Black Flying Fox would be placed at risk of extinction by the proposed upgrade.

Brolga *Grus rubicunda*

Description

The Brolga is one of only two cranes in Australia and is one of Australia's largest flying birds. It stands 1.3 m tall with a wingspan of nearly 2.5 m (Pizzey and Knight 2003). It is pale bright grey, with a broad band of bare red skin from the beak round the nape of the neck and a black dewlap under the chin (DECC). The long legs are black. The species is renowned for group-dancing displays (Pizzey and Knight 2003). They feed using their heavy straight bill as a 'crowbar' to probe the ground or turn it over, primarily on sedge roots and tubers. They will also take large insects, crustaceans, molluscs and frogs. The nest comprises a platform of grasses and sticks, augmented with mud, on an island or in the water.

Conservation status

The Brolga is listed as Vulnerable on the TSC Act.

Within the Northern Rivers Region, the Brolga has been predominantly recorded in the Clarence Valley and in Broadwater National Park, Bundjalung National Park, Yuraygir National Park and Tukean Nature Reserve. State-wide, the Brolga's distribution appears to be unrestricted to Conservation Reserves. Those where the Brolga has been recorded include: Nocoleche Nature Reserve; Yathong Nature Reserve; Round Hill Nature Reserve; Kinchega National Park; and, Mother Of Ducks Lagoon Nature Reserve. The species may be adequately represented within conservation reserves, at least on a local scale relevant to the Region.

Potential habitat within the study area could exist in farm dams, along creeks or stream margins, and on agricultural and cultivated land. These plant communities in the study area are considered to be of low to moderate habitat quality due to their modified, fragmented or isolated nature.

Habitat requirements

Brolga's are dependent on wetlands, especially shallow swamps but will often feed in dry grassland or ploughed paddocks or even desert claypans. They require

shallow (< 50 cm) wetlands and margins of deeper waterbodies with emergent vegetation for breeding. In the Northern Rivers Region they are known to be associated with Forested (Coastal Floodplain) Wetlands and Coastal Freshwater Lagoons (DECC).

To date, critical habitat has not been declared for the Brolga and therefore, the proposed upgrade is not likely to interfere with critical habitat for the Brolga.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands'. This would involve the removal or modification of potential roosting and nesting habitat for this species through the crossing of tributaries, streams and creeks (including Emigrant and Byron Creek) and disturbance to surrounding vegetation; although impacts on the waterways are expected to be minimised by proposed bridging of watercourses.

Further threats to the Brolga identified by the DECC include**:**

- At least in former times, Brolga's were poisoned and shot because of their feeding incursions into crops, following drainage of swamps; and,
- Loss of wetland habitat through clearing and draining for flood mitigation and agriculture.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified 9 priority actions to recover the species in NSW. Those most relevant to the proposed upgrade include:

- Educate all rural landholders about the importance of Brolga's and encourage them to retain wetland areas on their properties;
- Encourage landowners to fence off stock from wetland areas (or parts of) in order to retain or restore some habitat for the Brolga;
- Encourage landowners with suitable wetlands to enter into a VCA or other form of site protection for the Brolga;
- Retain or reintroduce water flows to wetlands, soaks, swamps; and,
- Identify at least 25 currently inhabited sites across the species range for management or recovery actions.

Local and regional abundance

Over 500 records of this species exist in NSW with nearly 200 records located within the Northern Rivers CMA (DECC Atlas of NSW Wildlife, Bionet). Three of these records fall within the Ballina LGA and two within the Byron LGA. Twelve records exist within the 10 km search area, with three being within 4 km of the study area .

Locations relative to limits of distribution

The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. The species is still abundant in the northern tropics, but very sparse, uncommon or rare across the southern part of its range (DECC)(Pizzey and Knight 2003).

Along the east coast of NSW, records are concentrated north of Port Macquarie, particularly centred on Grafton. Therefore, the study area is towards the limits of the species southern distribution.

Habitat (within study area)

Although there are no records of the Brolga within the study area, there are twelve records of the species within the Locality. Potential foraging habitat within the study area occurs in farm dams, and on agricultural and cultivated land. This habitat is considered to be in moderate to poor condition due to previous disturbance from agricultural and residential development. No SEPP 14 Wetlands occur within the study area.

To date, critical habitat has not been declared for the Brolga, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Although there is potential foraging habitat for this species within the study area, it occurs as small, fragmented stands along creeks and streamlines or on agricultural land and is considered to be in moderate to poor quality. The proposed upgrade would remove less than 1% of cleared grassland/pasture and waterside habitat in the Locality; but no SEPP 14 Wetland would be impacted.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect

impacts.

While some potential habitat may exist in the study area, it is unlikely any individual relies solely on this habitat. Given its reliance on wetlands for breeding, which do not occur in the study area, it is unlikely the removal of these small patches of potential foraging habitat will significantly affect the species lifecycle. As a seasonally migratory and nomadic species, the Brolga's high mobility would enable it to easily access habitat, including farmland, outside the development footprint. It is considered unlikely that a viable population of the Brolga will be placed at risk of extinction by the proposed upgrade.

Bush-hen *Amaurornis olivacea*

Description

The Bush-hen is a plain, dark rail with a bright green bill. It is identifiable by buff-coloured plumage under the belly and tail. It is a shy species, usually noticed by its braying call.

Conservation status

The Bush-hen is listed as Vulnerable on the TSC Act.

This species has been recorded nearby in Tuckean Nature Reserve, Victoria Park Nature Reserve, Uralba Nature Reserve, and Night Cap National Park. It has also been recorded farther north in Mount Jerusalem National Park. There are many more records from outside of conservation reserves. Although it has been recorded in a number of conservation reserves throughout its range, it is unknown whether this species is adequately represented in conservation reserves.

Potential habitat for this species occurs in the study area where Lowland Rainforest is present alongside permanent bodies of water. These patches in the study area are considered to be of low to moderate habitat quality due because they are highly fragmented and disturbed.

Habitat requirements

The Bush-hen is generally found in overgrown margins of permanent freshwater wetlands, usually in rainforests, often near rainforest margins, around swamps, or in grasslands butting forest edges, or secondary growth (Marchant and Higgins 1993b). The species usually requires dense undergrowth 2-4 m tall, especially tall, dense grass or dense thickets of Lantana or other shrubs (Marchant and Higgins 1993b). It has been recorded away from water on occasion, in long grass or Lantana (NPWS 2005).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes as listed in the TSC Act:

- 'Clearing of native vegetation';
- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' – This species is largely dependent on permanent bodies of freshwater;
- 'Predation by feral cats'; and,
- 'Predation by the European red fox'.

The Threat Abatement Plan relevant to the Bush-hen is the Fox Threat Abatement Plan. The aim of this plan is to reduce the impact of the European Red Fox on native animals and generally conserve biodiversity. The plan lists medium and high priority threatened species, and high priority geographic areas for which fox control should be focused. Neither the Bush-hen nor the study area is mentioned as a priority in the Fox Abatement Plan.

The DECC have prepared a list of priority actions to aid in the recovery of this species. The actions relevant to the proposed upgrade are listed below:

- Ensure that Bush-hens are considered in the preparation of weed management plans. Specifically, it must be recognised that Bush-hens readily utilise thickets of exotic species, such as *Lantana camara*;
- Weed control programs must ensure that suitable roosting sites in the form of dense vegetation are retained or replaced with native plants that provide a similar structure; and,
- Reduce nutrient runoff into freshwater wetlands known to be used by Bush-hens.

Local and regional abundance

In the broader region, there are many records close to the coast throughout the Ballina area and northwards to the Queensland border. Records are much scarcer west of the Great Dividing Range and south of the study area.The species is probably moderately uncommon in the Locality.

There are multiple (>10) records of the Bush-hen within the Locality, all on the coastal floodplains.

Location relative to limits of distribution

The Bush-hen is found in the Top End in the NT and in northern QLD. There is a possible gap in the distribution midway down the QLD coast, but the species is found from the Blackall Ranges to the Brisbane area. In NSW, the species ranges from the QLD border down to Grafton. The study area is near the southern limits of known distribution for this species.

Habitat (within study area)

Potential habitat for this species is present in the study area where dense undergrowth borders creeks or rivers. This habitat occurs within the study area in Lowland Rainforest. The patches of vegetation within the study area are considered to be in moderate condition, due to disturbances from agriculture clearing, which has heavily fragmented any remaining native vegetation.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Up to 2.0 ha of Lowland Rainforest would be removed and a further 3.6 ha indirectly affected, which represents less than 1% of potential habitat within the Locality. This figure represents an approximation of the quantity of Lowland Rainforest that would be removed. Not all of these habitat patches border permanent waterbodies or watercourses so the potential habitat to be cleared is expected to be smaller than this. Potential habitat for the Bush-hen exists in the Locality along rivers, creeks and their tributaries and SEPP 14 Wetlands, although no SEPP 14 Wetlands occur in the study area.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the briding of major watercourses will minimise indirect impacts.

Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would fragment potential habitat for the Bush-hen further. Little is known about the ecology of this species, but given the small area and low quality of habitat to be cleared, and the lack of further fragmentation, it is considered unlikely that a viable local population of the Bush-hen would be placed at risk of extinction by the proposed upgrade.

Comb-crested Jacana *Irediparra gallinacea*

Description

The Comb-crested Jacana is a small wading bird with exceptionally long toes that enable it to walk across floating vegetation without sinking. It has a white face, neck, and front with a dark breast band. It sports a red comb on its forehead.

Conservation status

The Comb-crested Jacana is listed as Vulnerable under the TSC Act.

This species has been recorded nearby in Tuckean Nature Reserve. It has also been recorded north in Tyagarah Nature Reserve and Night Cap National Park. Farther south, it has been recorded in Bundjalung National Park. The majority of records for this species in NSW occur outside of conservation reserves.

Potential habitat for this species occurs in the study area where permanent waterways with floating vegetation are present (e.g. farm dams). The species prefers deep, permanent wetlands, but can also be found in ephemeral wetlands (Marchant and Higgins 1993b).

Habitat requirements

The Comb-crested Jacana is found in freshwater wetlands, lagoons, billabongs, swamps, lakes, rivers and reservoirs, usually with abundant floating vegetation (Marchant and Higgins 1993b). This species appears to be dependent on floating vegetation, such as water lilies or other aquatic plants that form a thick mat on the water's surface. They will often leave an area when these plants are grazed by stock or water buffalo (Marchant and Higgins 1993b). The species also requires stable wetlands without great fluctuations in water level (Marchant and Higgins 1993b). Introduced weeds of waterways such as Water Hyacinth provide habitat for this species as well (Marchant and Higgins 1993b).

Key Threatening Processes, Recovery and Threat Abatement Plans

The Comb-crested Jacana is threatened by Key Threatening Processes listed in the TSC Act: 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands'. This species is largely dependent on permanent bodies of freshwater, and is sensitive to fluctuations in water flow/level.

No Threat Abatement Plan has been prepared for this species to date. The DECC has prepared a number of priority actions to aid in the recovery of this species in NSW. Those actions relative to the proposed upgrade are listed below:

- Maintain natural hydrological flows in wetland areas;

- Ensure the species is considered in Plans of Management and Fire Management strategies;
- Protect wetlands from flood mitigation works or clearing; and,
- Restore or maintain natural vegetation buffer to wetlands of 200 m or greater.

Local and regional abundance

The Comb-crested Jacana has been recorded six times in the Locality, between the study area and the coast. The species has been located on the Yarrenbool property at Newrybar (Ian Cooke, pers. comm.) on a dam that would be impacted by the proposed upgrade.

In the NSW North Coast Bioregion, it has a scattered distribution, mostly concentrated around the QLD border. South of the Locality, records are most common on the coast. The species is probably rare in the Locality and moderately common in the region.

Location relative to limits of distribution

This species is found in the northern reaches of WA, through the Top End in NT, the Gulf Country and Cape York. In the east of Australia, it is found along the QLD coast south to the Hunter Region. Some records from well inland also occur. The study area is not considered to be at or near the limits of known distribution for this species.

Habitat (in the study area)

In the study area, potential habitat for this species is mostly confined to farm dams and along creeks, rivers and their tributaries with floating vegetation. Within the study area, floating vegetation is uncommon due to large, fast moving creeks and tributary systems, although it is known to occur on some farm dams. It is possible the species may utilise swampy grasslands, but probably only as a stopover while passing through. SEPP 14 Wetlands do not occur in the study area.The patches of this vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current road, agriculture and clearing, which have caused disturbance and fragmented the vegetation into small stands. Many areas along rivers in the study area have been extensively cleared so that there is only a small buffer of riparian vegetation or none at all. It is unlikely that most aquatic habitats in the study area would be suitable for this species.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Less than 1% of suitable waterside habitat would be removed by the proposed upgrade. These habitat types are locally common along rivers, creeks and their tributaries within the Locality. No SEPP 14 Wetlands occur in the study area and not all waterside habitats in the study area are likely to be suitable for the Comb-crested Jacana.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect impacts.

The Comb-crested Jacana breeds in NSW from September to April, building a nest on floating or emergent vegetation and laying 2-4 eggs (Marchant and Higgins 1993b). This species' breeding habitat requirements are similar to its foraging habitat requirements. It is unlikely the proposed upgrade would have a major impact on the life-cycle of this species.

Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would further fragment potential habitat for the Comb-crested Jacana. Given the small area and low quality of habitat to be cleared, the large amount of potential habitat within the Locality and the lack of further fragmentation caused by the proposed upgrade, it is considered unlikely that a viable local population of the Comb-crested Jacana would be placed at risk of extinction by the proposed upgrade.

Common Blossom-bat *Syconycteris australis*

Description

The Common Blossom-bat is a small bat that feeds on nectar. Although it is very small (6 cm) (Menkhorst and Knight 2001), it is considered a type of megachiropteran, or fruit bat (Churchill 1998).

Conservation status

The Common Blossom-bat is listed as Vulnerable on the TSC Act.

The Common Blossom-bat has been recorded at Limeburners Creek Nature Reserve, Lake Innes and Crowdy Bay Nature Reserves (DEC Wildlife Atlas).

However, it is unclear how well represented this species is in these conservation reserves.

Potential habitat exists for this species within the study area in Lowland Rainforest. In the local area, this plant community largely occurs as fragmented patches and is considered of low to moderate habitat quality.

Habitat requirements

The most essential habitat feature for the Common Blossom-bat in the North Coast Bioregion is a mixture of heathland and coastal rainforest (Churchill 1998). This is because the species roosts only in rainforest, usually in the canopy, but requires heathland to forage in (Churchill 1998). The species occurs within subtropical rainforest, dry rainforest and vine thickets (DEC 2005a), but its use of different plant communities varies throughout its range (Lunney *et al.* 1995). Foraging areas may occur in adjacent heathlands and rainforest up to 4 km away from the roosting sites. The Common Blossom-bat feeds mostly on the nectar from Banksia flowers, but Melaleuca species are also important (Lunney *et al.* 1995). Individual bats roost in the foliage of the sub-canopy and are known to change roost sites daily. Changes in seasonal roost sites also occur in response to available resources.

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to the Common Blossom-bat include two Key Threatening Processes as listed on the TSC Act: 'Clearing of native vegetation' and 'Invasion of native plant communities by bitou bush and boneseed'. The proposed upgrade would involve clearing native vegetation that is potential habitat for the Common Blossom-bat and may allow for the further invasion of weeds that suppress the growth of key mid-storey food resources.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC lists recovery actions for the species. Those that are relevant to the proposed upgrade are listed below:

- Remove coastal weeds like Bitou Bush and Boneseed where it exists, but avoid aerial spraying during the flowering season of important heath species as herbicides can directly collect in flowers that are fed upon at night – a Flora/Fauna Management Plan written for the study area should take into account requirements of this species and any required weed control works;
- Protect areas of rainforest from clearing and development – approximately 2.0 ha of Lowland Rainforest will be cleared for the proposed upgrade; and,
- Ensure a mosaic of nectar-producing trees and shrubs, especially in coastal heath paperbark swamp, as well as rainforest roost habitat.

Local and regional abundance

The Common Blossom-bat has been recorded as far north as the Queensland border and south to Myall Lakes within NSW. In the NSW North Coast Bioregion, it has a largely coastal distribution.

In the Locality, the species has been recorded multiple (>10) times. Records tend to be along the coast.

Locations relative to limits of distribution

The species occurs on the east coast from Cape York to Myall Lakes. The species is limited in its distribution by its dependency on rainforest for shelter and foraging, and its tendency to rapidly enter torpor at a relatively high ambient temperature (Lunney *et al.* 1995). The study area is not considered to be at the limit of the species' distribution.

Habitat (within study area)

Lowland Rainforest provides potential roosting and foraging habitat for the common Blossom-bat in the study area.This habitat occurs as small, fragmented patches in the study area and is considered to be in moderate to poor condition, due to the small, fragmented nature of patches, and its modified structure and species composition.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of potential habitat for the Common Blossom-bat would be removed and a further 3.6 ha indirectly affected by the proposed upgrade. This represents less than 1% of potential habitat within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Little is known about the life cycle of the Common Blossom-bat. It is likely that the species breeds readily as long as safe roosting habitat in the form of a dense rainforest canopy is present.

Given that less than 1% of potential habitat for the Common Blossom-bat in the Locality would be impacted; fragmentation would not increase; the study area contains limited preferred roosting habitat (rainforest); the species is highly mobile,

and able to utilise better quality habitat in the surrounding Locality, it is unlikely that a viable local population of the Common Blossom-bat would be placed at risk of extinction by the proposed upgrade.

Common Planigale *Planigale maculata*

Description

The Common Planigale is a tiny marsupial carnivore with a body length of approximately 8 cm. It differs from a mouse in having a head that has a flattened appearance, the ears are larger and rounder, and the nose is more pointed.

Conservation status

The Common Planigale is listed as Vulnerable under the TSC Act.

In the region, this species has been recorded south and south-west of the study area in Tuckean Nature Reserve, Broadwater National Park, Bundjalung National Park, Doubleduke State Forest, and north of Byron Bay at Tyagarah Nature Reserve. Representation in conservation reserves appears moderate; although more records exist from outside conservation reserves than inside.

Potential habitat for this species exists in the study area in Lowland Rainforest vegetation. This plant community exists as small patches in the study area which are considered to be of low to moderate habitat quality due to their fragmented and disturbed nature.

Habitat requirements

The Common Planigale is known to occur in a variety of habitats including dry sclerophyll forest, heathland, grassland, subtropical and dray rainforest from sea level up to 400 m (Redhead 1995). Habitat selection is considered to be dependant on an adequate surface cover of grasses, hollow logs, rocks and leaf litter. This species is also known to shelter under man-made building materials discarded in bushland, such as galvanised iron.

Key Threatening Processes, Recovery and Threat Abatement Plans

Threats to this species include three Key Threatening Processes as listed on the TSC Act. They are:

- 'Clearing of native vegetation' – the proposed upgrade would involve clearing 2.0 ha of native vegetation that is potential habitat for the Common Planigale;

- 'Predation by feral cats'; and,
- 'Predation by the European Red Fox' – the proposed upgrade is unlikely to increase the level of predation by feral predators.

The Threat Abatement Plan relevant to the Common Planigale is the Fox Threat Abatement Plan. The aim of this plan is to reduce the impact of the European Red Fox on native animals and generally conserve biodiversity. The plan lists medium and high priority threatened species, and high priority geographic areas for which fox control should be focused. Neither the Common Planigale nor the study area is mentioned as a priority in the Fox Abatement Plan.

The DECC lists recovery actions for the Common Planigale. Those that are relevant to the proposed upgrade are listed below:

- Protect and enhance ground cover and understorey structure, especially near water; and,
- Stock removal and fencing, and feral predator control are measures that should be encouraged.

Local and regional abundance

In NSW, the Common Planigale has been recorded as far north as the Queensland border and south to the Upper Hunter River (Menkhorst and Knight 2001). In the NSW North Coast Bioregion, records of this species are predominantly from the coast, although some exist further inland.

The Common Planigale has been recorded multiple (>10) times within the Locality. One record exists within 1 km of the study area.In the Locality, it is known from Tuckean Nature Reserve. Other records within the Locality are found along the coast.

Locations relative to limits of distribution

The Common Planigale occurs on the east coast from Cape York to the Upper Hunter River. It is also found in the Northern Territory and the Kimberly in Western Australia. The study area is not considered to be at the limit of the species' distribution.

Habitat (within study area)

Habitat for the Common Planigale in the study area occurs within Lowland Rainforest. Much of the potential habitat for this species in the study area exists as small patches of vegetation that are considered to be in moderate to low condition, due to their small, fragmented nature, and modified structure and species

composition. Potential habitat that is of better quality than within the study area is present in the wider region.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of potential habitat for the Common Planigale would be removed with a further 3.6 ha affected by indirect impacts. This represents less than 1% of potential habitat occurring in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The Common Planigale has no special breeding requirements. In NSW, it breeds freely from October to January (Menkhorst and Knight 2001). It is likely that males and females live alongside one another and therefore do not need to travel far to find mates. The proposed upgrade is unlikely to have a significant impact on the life cycle of this species.

Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would further fragment potential habitat for the Common Planigale. Due to the present disturbed and fragmented nature of the habitat patches and the small proportion of habitat to be impacted within the Locality, it is unlikely that a viable local population of the Common Planigale would be placed at risk of extinction.

Coxen's (Double-eyed) Fig-Parrot *Cyclopsitta diophthalma coxeni*

Description

Coxen's, or Double-eyed, Fig-Parrot is a small, dumpy parrot with a short tail, large head, and robust beak. It is predominantly bright green with red and blue markings on the face. There are three distinct forms of the Double-eyed Fig-Parrot in Australia: Marshall's form, found in Cape York; Macleay's form, found in north-eastern QLD, and Coxen's form, found in south-eastern QLD and north-eastern NSW. This profile deals with Coxen's form only, which will henceforth be referred to as Coxen's Fig-Parrot.

Conservation status

Coxen's Fig-Parrot is listed as Endangered on both the TSC and EPBC Acts. It is considered one of Australia's most endangered birds with an estimated 200 birds

remaining (DECC).

The species has been recorded in Whian Whian State Conservation Area, near Night Cap National Park. It has also been recorded in Mount Jerusalem National Park and Mount Warning National Park to the north-west of the study area. Records are scarce and the species is considered inadequately represented in conservation reserves.

Potential habitat for the species exists in the study area within patches of Lowland Rainforest. Lowland Rainforest in the study area is considered to have low to moderate habitat quality as it consists as small, fragmented and disturbed patches.

Habitat requirements

Coxen's Fig-Parrot inhabits rainforests, preferably coastal rainforests or coastal subtropical rainforests (Higgins 1999). Presumably, much of its preferred habitat has been lost, forcing it to move into upland rainforests and wet sclerophyll forests (NPWS 2002b). It is dependent on native fruiting figs, feeding almost entirely on the seeds, which it extracts from the fruits (Higgins 1999).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes as listed in the TSC Act:

- 'Clearing of native vegetation' – 2.0 ha of native vegetation would be cleared by the proposed upgrade;
- 'Removal of dead wood and dead trees' – this species nests in dead trees and branches; and,
- 'Loss of hollow bearing trees' is a proposed Key Threatening Process. Coxen's Parrot nests in tree hollows.

No Threat Abatement Plan has been prepared for this species to date.

The DECC has prepared a Recovery Plan to address the critical status of the population of this species. Specific objectives of the Coxen's Fig-Parrot Recovery Plan are to:

- Protect and maintain wild populations and their habitat from human-induced threatening processes in the long term;
- Protect and maintain the full genetic diversity of Coxen's Fig-Parrot;
- Understand the ecology of Coxen's Fig-Parrot;

- Secure and breed a captive population of Coxen's Fig-Parrot; and,
- Increase the extent, quality and connectivity of the habitat of Coxen's Fig-Parrot.

The Recovery Plan details a host of recovery actions aimed at increasing the number of Coxen's Fig-Parrot's. The actions relevant to the proposed upgrade include protecting possible Fig-Parrot foraging habitat that exists within Coxen's Fig-Parrot's current range, including native fig trees that may be isolated, and ensuring survey techniques are adequate for identifying Coxen's Fig-Parrots if they are in the area.

Local and regional abundance

The species has probably never been very common, and is now considered critically endangered (NPWS 2002b). There is one record of the species in the Locality from 1987. There is one record from 1957 near Byron Bay, one from 1991 at Brunswick Heads and one from 1993 in Lismore. The species is rarely seen, feeding quietly in the canopy and flying infrequently (Higgins 1999, NPWS 2002b).

If the species had a stronghold in the NSW North Coast Bioregion, it would be in the very north of the state. It has recently been recorded in the Big Scrub National Park in southern QLD (Higgins 1999, NPWS 2002b).

Location relative to limits of distribution

The species has a very restricted distribution, found as far north as Bundaberg in QLD and as far south as the Hastings River in NSW. Its range extends inland to the Bunya Mountains. The study area is considered close to the southern limits of its distribution.

Habitat (within study area)

Potential habitat for this species exists in the study area in Lowland Rainforest. Patches of rainforest in the study area are considered to be of low to moderate habitat quality due to their disturbed and fragmented nature.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of potential habitat (Lowland Rainforest) for the species would be removed and a further 3.6 ha affected by indirect impacts, which represents less than 1% of similar habitat in the Locality.

Indirect impacts to the potential habitat for the species include an increase in

existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The breeding biology of Coxen's Fig-Parrot is very poorly known, but it is likely that the species breeds in northern NSW from October to January, laying two eggs (Higgins 1999). The species nests in the limb or trunk of a dead tree, or a dead limb on a live tree, or in any exposed dead or rotting branch (Higgins 1999). Due to the small area and disturbed nature of vegetation to be cleared, it is unlikely that the proposed upgrade would have a major impact on the life-cycle of this species.

While potential habitat exists within the study area, it is highly fragmented and disturbed, and better quality habitat occurs in the surrounding area. It is unlikely that the Coxen's Fig-parrot would rely solely on these small patches; particularly given that better quality habitat is present in the surrounding area. Furthermore, native fig tree communities which the species is largely dependent on are present, but limited, in the surrounding Locality. Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would fragment potential habitat for Coxen's Fig-Parrot. Due to the present disturbed and fragmented nature of the habitat patches and the small proportion of habitat to be impacted within the Locality, it is unlikely that a viable local population of the Coxen's Fig-parrot would be placed at risk of extinction.

Diamond Firetail *Stagonopleura guttata*

Description

The Diamond Firetail is a brown-backed finch with a bright red beak and rump, black-banded breast, and white-spotted flanks. It has a pale head, throat and lower breast and a grey head (Slater et al, 2003).

Conservation status

The Diamond Firetail is listed as Vulnerable on the TSC Act.

Local Conservation Reserves the species has been recorded in include Tyagarah Bay Nature Reserve.

It is not known whether this species is adequately represented in conservation reserves.

Potential habitat for the species occurs within the study area in lightly timbered

watercourses and in adjacent agricultural grassland.

Habitat requirements

Diamond Firetails are found in a variety of lightly timbered habitats including dry woodlands and open forests. They are often found in vegetation along watercourses (Marchant et al. 2006). They often inhabit open woodlands and forests, usually dominated by eucalypts such as Red Gums, with an open or sparse understorey (Marchant et al. 2006).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of limited potential foraging, roosting and nesting habitat for this species.

Several other activities have also been identified by the DECC or are considered likely to lead to the long-term decline of this species including:

- Clearing and fragmentation of woodland, open forest, grassland and mallee habitat for agriculture and residential development, and firewood collection.
- Poor regeneration of open forest and woodland habitats.
- Invasion of weeds, resulting in the loss of important food plants.
- Modification and destruction of ground- and shrub layers within habitat through: removal of native plants, litter and fallen timber; introduction of exotic pasture grasses; heavy grazing and compaction by stock; and, frequent fire.
- Predation of eggs and nestlings by increased populations of native predators such as the Pied Currawong *Strepera graculina*.
- Risk of local extinction due to small, isolated populations.

The DECC has identified the following factors to assist the recovery of this species:

- Search for the species in suitable habitat in areas that are proposed for development or management actions.
- Retain dead timber on the ground in open woodland areas.
- Reduce heavy grazing by domestic stock in areas of known or potential habitat, to enable flowering and subsequent seeding of grasses and forbs that

this species requires.

- Control weeds in areas of known habitat, especially the exotic, winter-fruiting shrubs such as cotoneasters, hawthorns, firethorns and privets that support Pied Currawongs.
- Retain and protect woodland, open forest, grassland and mallee habitat from clearing, fragmentation and disturbance; areas of 200 hectares or greater within woody vegetation are particularly significant, though this species also uses treeless grasslands in the Southern Tablelands.
- Expand and reconnect smaller fragments of habitat, by fencing and encouraging natural regeneration or applying revegetation techniques where regeneration fails.
- Ensure remnant populations remain connected or linked to each other; in cases where remnants have lost connective links, re-establish links by revegetating sites to act as stepping stones for dispersal.
- Identify key habitats or areas on a regional basis for protection and enhanced management through incentives.
- Conduct ecological research to determine habitat and resource requirements, threats and conservation issues.

Local and regional abundance

The Diamond Firetail is widespread in NSW, but is chiefly found in the foothills of the Great Dividing Range and farther inland, in temperate and semi-arid regions (Marchant et al. 2006). This species is not commonly found in coastal areas, although there are records from the Sydney area, the Hunter Valley, and the Bega Valley (DEC, 2005).

This species has been recorded in the Tyagarah Bay Nature Reserve and in Ewingsdale.

Locations relative to limits of distribution

The Diamond Firetail occurs mostly in the foothills of the Great Dividing Range and farther inland in NSW, but also ranges to the coast all the way to the Queensland and Victorian borders. The Region is not at the limits of distribution for the species.

Habitat (within study area)

Potential habitat occurs within the study area in timbered waterways and in adjacent agricultural grassland. These habitats include Lowland Rainforest. These

plant communities in the study area occur as small, fragmented and degraded patches and are considered to be in moderate to poor condition. Potential habitat within the study area is limited, with more suitable habitat occurring closer to the coast in eucalypt woodlands.

To date, critical habitat has not been declared for the Diamond Firetail, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Potential habitat for the Diamond Firetail exists in lightly timbered watercourses and grasslands.

The proposed upgrade would impact on less than 1% of grassland in the Locality. In addition, habitat in the study area is considered to be of poor to moderate quality due to its fragmentation and modification and thus is expected to provide limited habitat. These habitat types are locally common on agricultural land and along rivers, creeks and their tributaries within the Locality. This species is highly mobile, enabling it to easily access habitat outside the development footprint. Given the small size of the patches of vegetation to be impacted, that these patches are already subject to edge effects and that no new edge effects would be created by the proposed upgrade, it is considered unlikely that a viable local population of the Diamond Firetail would be placed at risk of extinction by the proposed upgrade.

Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*

Description

The Eastern Bent-wing Bat, *Miniopterus schreibersii oceanensis,* has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the "bent wing" appearance. It weighs up to 20 grams, has a head and body length of about 6 cm and a wingspan of 30 - 35 cm (DECC).

Conservation status

The Eastern Bent-wing Bat is listed as Vulnerable on schedule 2 of the TSC Act.

Within the Northern Rivers Region, the Eastern Bent-wing Bat has been recorded within reserves such as Kumbatine National Park, Nightcap National Park, Richmond Range National Park, Washpool National Park, Gibraltar Range National Park and Nymboida National Park. Many records of this species fall outside of conservation reserves. It is unclear if the species is adequately

represented in conservation reserves.

Within the study area, potential foraging habitat for the Eastern Bent-wing Bat occurs in Lowland Rainforest. In the Locality, this plant community occurs largely as small, fragmented disturbed patches within a rural landscape. There is potential roosting habitat in various man-made structures within the study area .

Habitat requirements

The Eastern Bent-wing Bat uses a broad range of habitats including rainforests, wet and dry sclerophyll forests, open woodlands and open grasslands (Churchill 1988). The species roosts in caves, but can also use manmade structures such as mines and road culverts (Churchill 1988, Dwyer 1995). Specific caves are used as nursery caves, containing a large number of individuals, which can be used year after year (Churchill 1988, Dwyer 1995).

The species also uses caves for roosting but may also use abandoned mines, buildings and storm water drains. The Eastern Bent-wing Bat forages for flying insects above the tree canopy (DEC 2005r). The species can travel many kilometres between roost sites.

Key Threatening Processes, Recovery and Threat Abatement Plans

The proposed upgrade would involve the operation of the Key Threatening Processes (KTP) 'Clearing of Native Vegetation' and 'Removal of dead wood and dead trees'. Clearing of Native Vegetation results in a loss of foraging habitat for the Eastern Bent-wing Bat and also results in the loss of habitat for important insect prey items.

To date, there is no Recovery Plan or Threat Abatement Plan for the Eastern Bent-winged Bat (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

The DECC lists a number of actions to help recover the species. Those relevant to the proposed upgrade are listed below:

- Retain native vegetation around roost sites, particularly within 300 m of maternity caves – no caves are present in the study area ; and,
- Protect roosting sites from damage or disturbance.

Local and Regional Abundance

There are over 300 records of the Eastern Bent-wing Bat in the Northern Rivers Region. The species has been recorded three times in the Locality. One of these

records is approximately 3 km south east of the study area .

Locations relative to limits of distribution

This species has a wide distribution throughout non-arid regions of NSW. The study area is not at the limit of distribution of the Eastern Bent-wing Bat.

Habitat (within study area)

Potential foraging habitat for the Eastern Bent-wing Bat occurs within the study area in Lowland Rainforest. Patches of vegetation within the study area are considered to be in moderate condition, due to impacts from the current road, residential/agricultural developments and clearing which have highly fragmented the vegetation. Man-made structures such as storm-water drains and buildings may provide roosting habitat for the species. The species requires caves for breeding, which are not present in the study area.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging habitat for the Eastern Bent-wing Bat. Potential habitat within the study area is considered to be of moderate to low quality, with better quality habitat present elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest (potential foraging habitat) would be removed by the proposed upgrade, with indirect impacts to a further 3.6 ha. This represents less than 1% of potential habitat within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The Eastern Bent-wing Bat requires caves for breeding, which are not present in the study area.Potential roosting habitat may occur in various man-made structures within the study area.These are unlikely to be affected by the proposed upgrade. The study area is unlikely to support a large maternal breeding colony and therefore, the proposed upgrade is unlikely to affect the species' lifecycle.

Given the highly modified nature, small size and existing fragmentation of the

patches of potential habitat to be impacted by the proposed upgrade, impacts on potential habitat are unlikely to reduce the quality of potential habitat for the Eastern Bent-wing Bat within the study area.The area of potential habitat to be cleared is very small and there is better quality habitat within the region outside the study area.Additionally, the species is highly mobile and the present level of habitat fragmentation would not increase as a result of the proposed upgrade. Mitigation measures would also be employed to offset indirect impacts of the proposed upgrade. Therefore, it is considered unlikely that a viable local population of the Eastern Bent-wing Bat would be placed at risk of extinction by the proposed upgrade.

Eastern Long-eared Bat *Nyctophilus bifax*

Description

The Eastern Long-eared Bat is a small to medium sized rainforest-dwelling microbat. It is tan to fawn in colour with large ribbed ears that join across the top of the head and a prominent noseleaf or expanded flange of skin around the nostrils. There are two subspecies, with the eastern subspecies *Nyctophilus bifax bifax* occurring in New South Wales (Strahan 1995b).

Conservation status

The Eastern Long-eared Bat is listed as Vulnerable on schedule 2 of the TSC Act.

Records of the Eastern Long-eared Bat are present in the nearby Tuckean and Victoria Park Nature Reserves and the Nightcap National Park (DECC Atlas of NSW Wildlife). Lack of representation in other nature reserves in the region could be due to a lack of surveys. More surveys would be required to determine whether this species is adequately represented in conservation reserves within the region.

Within the study area, potential habitat for this species occurs in Lowland Rainforest which provides roosting, foraging and breeding habitat for the Eastern Long-Eared Bat. In the Locality, this plant community occurs largely as small fragmented patches within a rural landscape and is considered to be of low to moderate habitat quality.

Habitat requirements

In Northern New South Wales, the Eastern Long-eared Bat is restricted to rainforest habitats (Churchill 1998). They roost in hollows in trees and also in the hanging foliage of palms, in dense clumps of foliage of rainforest trees and under bark (Churchill 1998, DEC 2005s). Tree hollows are more commonly used as maternity roosts while foliage roosts are utilised in the mating season (Churchill 1998). It forages on the edge of the rainforest canopy on moths, ants and beetles. It is a slow

and manoeuvrable flier (Churchill 1998).

Key Threatening Processes, Recovery and Threat Abatement Plans

The proposed upgrade would involve the operation of the Key Threatening Process (KTP) 'Clearing of Native Vegetation'. In addition, the Eastern Long-eared Bat is listed as being reliant on tree hollows in the preliminary determination for the proposed KTP declaration for 'Loss of Hollow-bearing Trees'. Clearing of Native Vegetation results in a loss of foraging, roosting and breeding habitat for the Eastern Long-eared Bat and also results in the loss of habitat for important insect prey items. The Loss of Hollow-bearing trees results in the loss of important roosting habitat, including maternity roosts for this species.

To date, there is no Recovery Plan or Threat Abatement Plan for the Eastern Long-eared Bat
(http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

Local and regional abundance

On a state level, records of the Eastern Long-eared Bat are mainly confined to within about 100 km of the coast but some records are present from inland NSW, presumably from wetland/river systems (DECC Atlas of NSW Wildlife, Bionet). Its range extends from the Queensland border south to the Clarence River area, with a few scattered records south of Coffs Harbour. Within this area it is restricted to the coastal plain and nearby coastal ranges.

It is unclear whether the species occurs within the study area ; bats of the *Nyctophilus* genus (i.e Long-eared Bats) were recorded by ultra-sonic detectors during the survey, but could be the common species *N. gouldi* or *N. geoffroyi*. The Eastern Long-eared Bat was not recorded within the study area during previous surveys. The Eastern Long-eared Bat has been recorded on multiple (>10) occasions in the Locality; mainly in the coastal forests to the east of the proposed upgrade.

Locations relative to limits of distribution

The study area is about 60 km from the limit of the main distribution of the Eastern Long-eared Bat (DECC Atlas of NSW Wildlife; Bionet). Therefore, populations of the Eastern Long-eared Bat that may occur within the study area are considered important populations because the Study Site is near the limit of the species southern distribution.

Habitat (within study area)

Potential habitat for the Eastern Long-eared Bat occurs within the study area in Lowland Rainforest. This vegetation provides potential foraging, roosting and

breeding habitat. Patches of vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current road, residential/agricultural developments and clearing, which have fragmented the vegetation into small patches.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential roosting/breeding habitat and clearing of potential foraging habitat for the Eastern Long-eared Bat. Potential habitat within the study area is considered to be of moderate to poor quality with better quality habitat occurring elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest (potential habitat) would be removed, with indirect impacts to a further 3.6 ha. This represents less than 1% of potential habitat that occurs within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Eastern Long-eared Bat within the study area.

The populations of the Eastern Long-eared Bat within the region are important populations because they occur near the southern edge of the species' range. While potential habitat exists within the study area, it is highly fragmented and disturbed, and better quality habitat occurs in the surrounding area. It is unlikely that the Eastern Long-eared Bat would rely solely on these small patches; particularly given that better quality habitat is present in the surrounding area. Additionally, the species is highly mobile and the present fragmentation of the potential habitat would not increase as a result of the proposed upgrade. It is therefore considered unlikely that a viable local population of the Eastern Long-eared Bat would be placed at risk of extinction by the proposed upgrade.

Eastern Tube-nosed Bat *Nyctimene robinsoni*

Description

The Eastern Tube-nosed Bat is a medium-sized fruit bat with distinctive long tube-like nostrils and yellow spots across its wings ears and nose (Churchill 1998).

Conservation status

The Eastern Tube-nosed Bat is listed as Vulnerable on the TSC Act.

The species is relatively uncommon in NSW, only one record exists in the southern part of the state, near Canberra, while the remaining 36 records occur along the northern coast of NSW and do not reach further than 100 km south of the Queensland border (DECC). The species is not adequately represented in NSW conservation reserves, having only been recorded in the northern region's Nightcap National Park (four records) and Mebbin National Park (one record).

Within the study area, potential habitat for the species occurs in Lowland Rainforest and Camphor Laurel. In the local area, these plant communities largely occur as fragmented patches within a rural landscape.

Habitat requirements

Eastern Tube-nosed Bats generally roost alone but has been recorded in groups of up to five animals. They usually roost within a kilometre of their foraging habitat (Spencer and Fleming 1989), and in NSW this is range is likely to be closer to 200 m (Churchill 1998). Although little has been published regarding the Eastern Tube-nosed Bat's foraging requirements, a study in far north Queensland documented foraging on rainforest canopy trees (such as *Ficus*, *Eugenia* and S*yzygium*) as well as Banksia flowers and introduced fruiting trees (Churchill 1998) (Spencer and Fleming 1989). Due to the scarcity of information detailing the preferred feed trees of the Eastern Tube-nosed Bat, the stands of introduced Camphor Laurel within the study area have been included as potential habitat for this species as they contain fleshy fruit and therefore may be utilised for foraging and roosting.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of feed trees and potential roosting habitat for this species.

Further threats to the Eastern Tube-nosed Bat identified by the DECC include**:**

- Clearing and fragmentation of rainforest and wet eucalypt forest for

agriculture and residential development;

- Loss and degradation of habitat due to disturbance of rainforest and wet eucalypt forest from timber harvesting;
- Invasion of rainforest habitat by introduced weeds; and,
- Destruction of Black Bean, an important food tree, because the seeds are toxic to cattle.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified 20 priority actions and recovery options for the species. Those most relevant to the proposed upgrade include:

- Ensure rainforest is given highest priority for retention in PVP assessments (offsets should include remnants in high productivity) and/or other land assessment tools;
- Control and remove invasive introduced weed species from known localities of the species;
- Initiate and support sub-tropical rainforest and wet eucalypt forest regeneration projects, including reconnection of isolated patches;
- Implement recommendations in regard to barbwire fences adjacent to known localities and in areas where entanglements have been reported (e.g. through WIRES);
- Identify the effects of fragmentation on the species in a range of fragmented landscapes. For example movement and persistence across a range of fragment sizes;
- Research to identify important foraging range and key habitat components for this species;
- Identify areas of private land that contain key habitat for the species (e.g. streamside rainforest stands of Black Bean) as areas of HCV in planning instruments and land management negotiations; and,
- Undertake localised surveys in sub-tropical rainforest of far northern NSW to improve knowledge of distribution.

Local and regional abundance

There are 37 DECC records of the Eastern Tube-nosed Bat in NSW, only one of which is located further south than Ballina. Although the species was not observed in the study area during the current surveys, it has been recorded within 10 km of

the study area. Little is known of the local and regional abundance due to a lack in documented survey effort for this species in NSW and nationally. Incidental observations of this species are also less likely than for other fruit bats as they roost solitarily rather than in conspicuous camps, and are reported to be cryptic, resembling dead leaves, and difficult to detect while roosting (Churchill 1998) (Spencer and Fleming 1989).

Locations relative to limits of distribution

Distribution of the Eastern Tube-nosed Bat is mostly coastal and extends from far north Queensland south to the north-eastern corner of NSW, near Ballina (NSW Government, BioNet 2008). While there is one record for this species in the southern part of the state near Canberra, until further survey effort is completed to investigate the possibility of a southern population, the study area can be considered to be at the southern limit of the range of the Eastern Tube-nosed Bat.

Habitat (within study area)

Lowland Rainforest and Camphor Laurel may provide potential roosting and foraging habitat for the Eastern Tube-nosed Bat in the study area. This habitat occurs as small, fragmented patches in the study area and is considered to be in moderate to poor condition, due to the small, fragmented nature of patches, and its modified structure and species composition. However, it should be noted that no studies to date have investigated the use of habitat fragments by the Eastern Tube-nosed Bats and roosting in isolated trees has been recorded for this species (Spencer and Fleming 1989).

To date, critical habitat has not been declared for the Eastern Tube-nosed Bat; and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging and roosting habitat for the Eastern Tube-nosed Bat. Potential habitat within the study area is considered to be of moderate to poor quality and better quality habitat for this species exists elsewhere in the Locality (for example, larger continuous patches of rainforest habitat within nearby nature reserves).

Approximately 7.7 ha of Lowland Rainforest and Camphor Laurel (potential habitat) would be removed by the proposed upgrade. This represents less than 1% of potential habitat that occurs within the Locality. Vegetation mapping within the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to potential habitat for this species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already completely subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts. Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, indirect impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Eastern Tube-nosed Bat within the study area.

The area of habitat that would be cleared is small, particularly when compared to the amount of potential habitat within the Locality. Given that fragmentation is unlikely to increase, it is considered unlikely that a viable local population of the Eastern Tube-nosed Bat would be placed at risk of extinction by the proposed upgrade.

Freckled Duck *Stictonetta naevosa*

Description

The Freckled Duck is a dark, greyish-brown bird with a large head that is peaked at the rear, and a distinctive narrow, slightly up-turned bill. Their dark brownish-black plumage is evenly freckled all over with white or buff. They feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates.

Conservation status

The Freckled Duck is listed as Vulnerable on the TSC Act.

The Murray-Darling Basin, Lake Eyre and south-western Queensland, forms the eastern breeding stronghold for the Freckled Duck (Pizzey and Knight 2003). The species has been recorded in Conservation Reserves across Australia: Nocoleche Nature Reserve, Cecil Hoskins Nature Reserve, Pitt Town Nature Reserve, Kooragang Island Nature Reserve, Sturt National Park, Narran Lake Nature Reserve, Macquarie Marshes Nature Reserve, Nearie Lake Nature Reserve, Kinchega National Park, Morrisons Lake Nature Reserve, Willandra National Park, Round Hill Nature Reserve (DECC Atlas of NSW Wildlife). It has not been recorded within conservation reserves in the Northern Rivers region.

Potential habitat within the study area exists in small miscellaneous water bodies (e.g. farm dams), rivers, lakes and streams. These habitats in the study area are considered to be of low to moderate condition due to their modified, fragmented

and isolated nature. No SEPP 14 Wetlands occur in the study area .

Habitat requirements

The Freckled Duck prefers permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. They generally rest in dense cover during the day, usually in deep water. Nests are usually located in dense vegetation at or near water level.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands'. This would involve the removal or modification of potential foraging, roosting and nesting habitat for this species through the crossing of dams and watercourses and disturbance to surrounding vegetation. However, impacts on the waterways are expected to be minimal and further reduced by the bridging of larger watercourses and the implementation of mitigation measures (sedimentation control).

Further threats to the Freckled Duck identified by the DECC include**:**

- Illegal shooting;
- Grazing and trampling of wetland habitat by grazing stock;
- Draining and clearing of wetland and swamp habitat; and,
- Changes to natural river flows and flood patterns as a result of dams, weirs and irrigation.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified recovery strategies, including seven priority actions to recover the species in NSW. Those most relevant to the proposed upgrade include:

- Retain or reintroduce ecologically sustainable water flows to swamp, wetland and creek habitat;
- Assess wetland health and threats, including frequency of inundation, condition of and threats to key plant species such as lignum, degree of alteration to water flows and appropriate flow regimes (frequency & extent) to sustain breeding; and,

- Identify, describe (wetland type, vegetation and hydrology) and map important 'breeding' and 'non-breeding' wetlands and identify which wetlands are currently being utilised by Freckled Ducks.

Local and regional abundance

There are over 400 records of the species in NSW (Bionet; DECC Atlas of NSW Wildlife). Thirty to forty of these records fall within the Northern Rivers CMA. The Freckled Duck has been recorded three times within the Locality from 1981 and 1989. There are multiple records within Ballina and Byron LGA's.

Locations relative to limits of distribution

The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere (e.g. coastal districts in drought years) (Marchant and Higgins 1990). The Freckled Duck is forced to disperse during extensive inland droughts. The study area is towards the limits of the species northern distribution on the east coast.

Habitat (within study area)

Although there are no records of the Freckled Duck within the study area, there are three records of the species within the Locality. The species could also use small water bodies (e.g. farm dams), rivers, lakes and streams within the study area as foraging habitat. No SEPP 14 Wetlands occur in the study area.The species is thought to be a visitor of the region only in times of inland drought.

To date, critical habitat has not been declared for the Freckled Duck and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Although there is potential foraging habitat for this species within the study area, it occurs as small, disturbed patches on farm dams, creeks and streamlines or on agricultural land, and is considered to be of moderate to poor habitat quality. The proposed upgrade would remove less than 1% of habitat adjacent to wetlands from the Locality and no Wetland habitat is expected to be significantly impacted.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect

impacts.

The habitat in the study area is not considered prime habitat for the Freckled Duck. Given its preference for permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree, which are limited in the study area, it is unlikely the removal or modification of these small patches of potential wetland habitat will affect the species. It is unlikely that these habitats constitute important breeding habitat for the species. As a seasonally migratory and nomadic species, the Freckled Duck's high mobility would enable it to easily access habitat, outside the development footprint. It is considered unlikely that a viable local population of this species will be placed at risk of extinction by the proposed upgrade.

Grass Owl *Tyto capensis*

Description

The Grass Owl is very similar in appearance to the Barn Owl, being of a similar size and colouration. It can be identified by its relatively longer legs that protrude well beyond the tail in flight, and its orange-washed breast. It roosts and nests on the ground.

Conservation status

The Grass Owl is listed as Vulnerable under Schedule 2 of the TSC Act.

The species has been recorded in Tyagarah Nature Reserve, north-east of the study area, and also in Broadwater National Park and Bundjalung National Park to the south of the study area.The species is probably not adequately represented in conservation reserves in NSW.

Potential habitat for this species occurs in the study area in grasslands and swampy heaths. This includes cleared land such as paddocks where the grass is long enough to provide cover. The vegetation in the study area is considered to be of poor to moderate habitat quality, as it is heavily disturbed and fragmented.

Habitat requirements

Records of the Grass Owl are rare and strictly associated with the occurrence of suitable habitat. Grass Owls mainly inhabit open tussock grassland, usually in treeless areas. However, they have been recorded in grassland interspersed with tree-lined creeks. This species can also occur in marshy areas within tall dense tussocks of grass in swampy depressions or on floodplains (Higgins 1999). The Grass Owl is also known from mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey and Knight 1997). The Grass Owl breeds on the ground among

dense clumps of tall grasses or sedges. It feeds primarily on rodents, foraging aerially over treeless areas, marshy ground vegetated with grass tussocks or low heath, paddocks and roadsides (Higgins 1999).

Key Threatening Processes, Recovery and Threat Abatement Plans

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on potential habitat for the Grass Owl include:

- 'Clearing of native vegetation' – 2.0 ha of native vegetation would be cleared by the proposed upgrade; and,
- 'Ecological consequences of high frequency fires' – the proposed upgrade is unlikely to increase the frequency of fires.

There has been no recovery or Threat Abatement Plans prepared for this species to date. There are no priority actions listed that are relevant to the proposed upgrade.

Local and regional abundance

There are more than 20 records of this species in the Locality, although it has not been recorded in the study area.It is probably moderately common in the Locality.

Within the Region, records are less common and usually from coastal areas. The species is probably uncommon in the NSW North Coast Bioregion.

Location relative to limits of distribution

The Grass Owl has been recorded in all states, but appears most common in the country's north and north-east (DEC 2005x). In NSW, it is most commonly found on the north coast, but records exist from farther south. The study area is not considered to be at or near the limits of its distribution.

Habitat (Within study area)

Potential habitat for this species in the study area occurs in cleared land where the grass is long. Wet depressions can also be found in the study area, and may provide potential habitat for the Grass Owl. Due to the species' preference for treeless areas, habitat for the Grass Owl within the study area would be found in cleared land. This habitat is considered to be in moderate to poor condition, due to impacts from rural, agricultural and residential development and clearing.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would involve possible clearing of potential foraging and nesting habitat for the Grass Owl. However, better quality habitat for this species exists elsewhere in the Locality (for example, larger continuous patches of habitat within nearby nature reserves). It is estimated that potential habitat to be cleared represents less than 5% of potential habitat which occurs within the Locality. These habitat types are locally common on agricultural land and along rivers, creeks and their tributaries within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The Grass Owl nests in grass tussocks on the ground in the same habitat as it forages in. The proposed upgrade is unlikely to have a major impact to the life-cycle of the species.

The species is highly mobile enabling it to utilise habitat outside the development footprint. Habitat fragmentation would not increase and mitigation measures would be employed to offset indirect impacts of the proposed upgrade. Only a small area of habitat is to be cleared, with a large amount of potential habitat existing within the Locality. Considering these factors, it is considered unlikely that a viable local population of the Grass Owl would be placed at risk of extinction by the proposed upgrade.

Greater Broad-nosed Bat *Scoteanax rueppellii*

Description

The Greater Broad-nosed Bat is a large powerful microbat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below.

Conservation status

The Greater Broad-nosed Bat is listed as Vulnerable on the TSC Act.

The extent to which this species is represented in conservation reserves is unclear. Locally, the species has been recorded in Washpool National Park, Crowdy Bay

National Park, Clarence Estuary Nature Reserve and Sherwood Nature Reserve.

Potential habitat exists in the study area in Lowland Rainforest, particularly that found along creeks, streams and their tributaries. Patches of Lowland Rainforest in the study area are considered of low to moderate habitat quality due to their fragmented and disturbed nature.

Habitat requirements

The Greater Broad-nosed Bat prefers moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill 1998). In dense vegetation they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Dwyer 1995). This species roosts in hollow tree trunks and branches (Churchill 1998).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the Key Threatening Process (KTP) 'Clearing of Native Vegetation'. In addition, the Greater Broad-nosed Bat is listed as being reliant on tree hollows in the preliminary determination for the proposed KTP declaration for 'Loss of Hollow-bearing Trees'. Clearing of native vegetation results in a loss of foraging, roosting and breeding habitat for the Greater Broad-nosed Bat and also results in the loss of habitat for important insect prey items. The loss of hollow-bearing trees results in the loss of important roosting habitat, including maternity roosts for this species.

Further threats to the Greater Broad-nosed Bat identified by the DECC include:

- Disturbance to roosting and summer breeding sites;
- Foraging habitats being cleared for residential and agricultural developments, including clearing by residents within rural subdivisions;
- Loss of hollow-bearing trees;
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individuals' fat stores; and,
- Changes to water regimes are likely to impact food resources, as is the use of pesticides and herbicides near waterways.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified recovery strategies including 19 priority actions to recover the species in NSW. Those most relevant to the proposed upgrade

include:

- Actively encourage the conservation of riparian vegetation and water quality of streams and rivers;
- DECC should be consulted when planning development/s to minimise impact/s on populations;
- Conduct searches for the species in suitable habitat in proposed upgrade areas;
- Retain stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats;
- Retain a buffer of vegetation around roost sites in vegetated areas;
- Protect hollow-bearing trees for breeding sites, including those on farmland; younger mature trees should also be retained to provide replacements for the older trees as they die and fall over; and,
- Assess the site's importance to the species' survival, including linkages provided between ecological resources across the broader landscape.

Local and regional abundance

Wide scattered records of the Greater Broad-nosed Bat occur throughout the northeast of NSW from coastal areas to the Tablelands. Over 100 records of the species occur in the Northern Rivers CMA (Bionet).

The Greater Broad-nosed Bat has been recorded three times within the 10 km search area to the southeast and northeast of the study area.It has not been recorded in the study area .

Locations relative to limits of distribution

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tablelands. It extends to the coast over much of its range. In NSW, the distribution of the Greater Broad-nosed Bat extends along coastal regions from the northern NSW border to the South Coast. It does not occur at altitudes above 500 m (DECC). The study area is not at the limits of the species distribution.

Habitat (within study area)

Potential habitat for the Greater Broad-nosed Bat occurs within the study area in the Lowland Rainforest. This habitat provides potential foraging, roosting and breeding sites, especially when situated along waterways. The patches of vegetation within

the study area are considered to be in moderate to poor condition, due to impacts from the current road, residential/agricultural developments and clearing, which have fragmented the vegetation and caused a high level of disturbance.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species

The proposed upgrade would involve clearing of potential roosting/breeding habitat and clearing of potential foraging habitat for the Greater Broad-nosed Bat. Potential habitat within the study area is considered to be of moderate to poor quality, with better quality habitat for this species existing elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest (potential habitat) would be removed, with indirect impacts to a further 3.6 ha. This represents less than 1% of potential habitat that occurs within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Greater Broad-nosed Bat within the study area .

Little is known of the species' reproductive cycle, although a single young is born in January. Prior to giving birth, females congregate at maternity sites located in suitable trees. Females appear to exclude males during the birth and raising of the young (DECC). Due to the lack of hollows in the study area, it is unlikely the small, disturbed patches of rainforest present contain core breeding sites. Therefore, it is unlikely the proposed upgrade would affect the life-cycle of the Greater Broad-nosed Bat.

The area of potential habitat to be cleared is very small and there is better quality habitat in the region than that within the study area.Additionally, the species is highly mobile and the present fragmentation of the potential habitat would not increase as a result of the proposed upgrade. It is therefore considered unlikely that a viable local population of the Greater Broad-nosed Bat would be placed at risk of

extinction by the proposed upgrade.

Green and Golden Bell Frog *Litoria aurea*

Description

The Green and Golden Bell Frog is a medium-size, stout frog, usually pea green in colour with brass or gold-coloured spots on the back. A cream stripe runs down the side of the body from the eye almost to the groin.

Conservation status

The Green and Golden Bell Frog is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act.

The species has been recorded in Tyagarah Nature Reserve north of the study area, but the species is no longer considered to be present at this location (NPWS 1999d). In the wider region it has been recorded in Yuraygir National Park south of Iluka, and Hat Head National Park near South West Rocks. The species is not considered adequately represented in conservation reserves.

Potential habitat for this species exists in the study area in still or slow flowing waterbodies such as tributaries or farm dams with suitable aquatic and surrounding vegetation. Habitat in the study area is considered to be of low to moderate habitat quality due to their fragmented nature and due to the presence of *Gambusia holbrooki*, which are a predator of tadpoles. No SEPP 14 Wetland occurs in the study area.

Habitat requirements

The Green and Golden Bell Frog is known to occupy areas with a variety of habitat features throughout its range. However, there are important habitat components that the species requires to survive, including ephemeral water bodies, grassy surroundings for foraging and refuge, shelter sites, basking sites and over-wintering sites (Pyke and White 2001). The presence of exotic predatory fish *Gambusia holbrooki* is considered a crucial limiting factor, affecting the long-term survival of the Green and Golden Bell Frog (Pyke and White 2001). The species breeds in any still or slow flowing waterbodies with some aquatic emergent vegetation such as *Typha* spp. or *Eleocharis* spp. They will use exotic emergent vegetation. The Green and Golden Bell Frog forages amongst emergent aquatic or riparian vegetation and amongst vegetation, fallen timber adjacent to breeding habitat, including grassland, cropland and modified pastures.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key threatening processes which are identified under Schedule 3 of the TSC Act as affecting the Green and Golden Bell Frog are:

- Predation by the Feral Cat *Felis catus*;
- Predation by the European Red Fox *Vulpes vulpes*;
- Predation by *Gambusia holbrooki* (e.g. Plague Minnow or Mosquito fish);
- Clearing of native vegetation;
- Bushrock removal; and,
- Infection by *Amphibian chytriomyotis*.

The Threat Abatement Plan relevant to the Green and Golden Bell Frog is the Fox Threat Abatement Plan. The aim of this plan is to reduce the impact of the European Red Fox on native animals and generally conserve biodiversity. The plan lists medium and high priority threatened species, and high priority geographic areas for which fox control should be focused. Neither the Green and Golden Bell Frog nor the study area is mentioned as a priority in the Fox Abatement Plan. The proposed upgrade is unlikely to increase the level of predation on this species.

There is also a Threat Abatement Plan to address predation by the Plague Minnow. This plan aims to reduce the impact of the Plague Minnow on threatened species. The plan outlines management procedures to minimise human-aided distribution of the Plague Minnow and control measures where practical. The proposed upgrade does not introduce any issues that are not in agreement with this Threat Abatement Plan.

There is a draft Recovery Plan that has been prepared for this species by the DECC. The objectives of this plan are to:

- Increase security of existing the Green and Golden Bell Frog populations;
- Protect extant populations from known threats;
- Implement habitat management;
- Establish captive populations; and,
- Increase the level of local and regional awareness.

Other priority actions relevant to the proposed upgrade include:

- Consent/determining authorities to consider this plan and the DECC Green and Golden Bell Frog guidelines when assessing the impact of development and activity proposed upgrades.

Local and regional abundance

Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations (DECC Atlas of NSW Wildlife).

Records in the region indicate that the species is uncommon in the region and the Locality. This species is usually present in small, localised populations. One such population exists at Yuraygir National Park south of the study area, another in Clybucca, and another in the southern part of the region near Crescent Head.

This species is known in the Locality from four records from the 1980s scattered to the east of the study area.It is unlikely that the Green and Golden Bell Frog is present within the study area.

Location relative to limits of distribution

The species ranges along the eastern coast from NSW to Victoria. Records from NSW indicate locations occur over the species' former range; although they are widely separated and isolated. The study area is at the northern limits of the species' distribution.

Habitat (within the study area)

Potential habitat for this species occurs in still or slow flowing waterbodies such as tributaries or farm dams with suitable aquatic and surrounding vegetation. However, the habitat within the study area is considered to be of low quality as it is fragmented, modified, and degraded by invasive species (*Gambusia*) and agricultural stock. There are no SEPP 14 Wetlands in the study area and watercourses are generally fast moving.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would involve clearing of potential foraging and breeding habitat and potentially, the alteration of natural flow of wetlands for the Green and Golden Bell Frog. Potential habitat within the study area is considered to be of low quality, with better quality habitat for this species existing elsewhere in the Locality. Potential habitat to be cleared represents less than 1% of potential habitat that occurs within the Locality. These habitat types are locally common along rivers, creeks and their tributaries within the Locality. SEPP 14 Wetlands are also present in the Locality. Therefore, the amount of potential habitat for the Green and

Golden Bell Frog to be impacted by the proposed upgrade represents a small proportion of that available in the Locality. Not all aquatic habitats in the study area are likely to be suitable for the Green and Golden Bell Frog.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect impacts.

Given the already fragmented and degraded nature of potential habitat and proposed mitigation measures to limit indirect impacts, it is unlikely the proposed upgrade would fragment potential habitat for the Green and Golden Bell Frog further. Given the small amount and poor quality of habitat for this species in the study area, it is unlikely that a viable local population of the Green and Golden Bell Frog would be placed at risk of extinction by the proposed upgrade.

Grey-headed Flying Fox *Pteropus poliocephalus*

Description

The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23 - 29 cm. It has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck (Churchill 1998). The wing membranes are black and the wingspan can be up to 1 m. It can be distinguished from other flying-foxes by the leg fur, which extends to the ankle (DECC).

Conservation status

The Grey-headed Flying Fox is listed as Vulnerable on the TSC Act and Vulnerable on the EPBC Act. It is endemic to Australia.

It is not clear how well represented this species is in conservation reserves. There is some level of protection to camps while they are occupied, but the land tenure of many camps means they are not protected when not occupied (Eby 1995). In NSW, Grey-headed Flying-foxes have been recorded in numerous conservation reserves along the east coast, and the tablelands and eastern slopes of the Great Dividing Range. Locally, the species has been recorded in Wollumbin National Park, Marshalls Creek Nature Reserve, Bundjalung National Park, Ballina Nature Reserve, Boat Harbour Nature Reserve, Tuckean Nature Reserve, Broadwater National Park and Bungawalbin National Park.

Habitat for this species exists in the study area in Camphor Laurel and Lowland

Rainforest. These plant communities in the study area are considered to be of low to moderate habitat quality due to their fragmented and degraded nature.

Habitat requirements

Grey-headed Flying Foxes are found in a variety of habitats, including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas (Churchill 1998). The species is a canopy-feeding frugivore and nectarivore. Their major food source is Myrtaceae blossom (mostly eucalypt) and fruits such as Native figs (*Ficus spp*.) and cultivated fruit orchards (Churchill 1998). Bats commute daily to foraging areas, usually within 15 km of the day roost (Strahan 1995a), although some individuals may travel up to 70 km. Grey-headed Flying Foxes seasonally congregate in large camps of up to 200,000 individuals (Churchill 1998). The availability of blossom in the surrounding area influences the number of bats in a camp, which are commonly formed in gullies close to water with dense canopy vegetation (Churchill 1998).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of feed trees and potential roosting and nesting habitat for this species.

Further threats to the Grey-headed Flying Fox identified by the DECC include:

- Clearing and modification of native vegetation, reducing availability of camp habitat and foraging resources;
- Destructive methods of bat deterrents and shooting;
- Electrocution on power lines;
- Disturbance and direct harassment at roosts and camps; and,
- Potential competition and hybridisation from Black Flying-foxes.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified 31 priority actions and lists recovery actions for the species. One of these involves the production of a National Recovery Plan for the species in 2007.

Local and regional abundance

Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria (Eby 2000). At any one time, the majority of animals only occupy a small proportion of this

entire range. Over 800 records exist for this species within the Northern Rivers CMA (DECC). Care should be taken when assessing abundance of the species as Grey-headed Flying Foxes in northern and central NSW appear to function as a single breeding population and should be managed as such (Eby 1991).

The Grey-headed Flying Fox was recorded within the study area during the current surveys and multiple records (>20) are located within 10 km of the study area.Three of these records account for 200 to 10,000 individuals. No camps were identified within the study area.Two camp sites are known to occur within the local area, one just north of Ballina near the North Creek Canal and the other east of the proposed road corridor within the Radburn property, approximately 1 km northeast of Hogans Bluff. Known camps within the Region are located in Currie Park, Lismore and Susan Island, Grafton.

Locations relative to limits of distribution

The distribution of the species which formerly ranged north to Rockhampton, has contracted south (Eby 2000). It now occurs along the east coast of Australia from Rockhampton to western Victoria (Churchill 1998). The Grey-headed Flying Fox is confined to the east coast of Australia. The study area is not at the limit of the species distribution.

Habitat (within study area)

Shelter and roosting habitat exists in canopy trees in patches of forest within 40 km of forage resources (DECC). Breeding habitat occurs in canopy trees associated with rainforest, coastal scrub, riparian or estuarine communities and with sufficient foraging resources within 40 km (DECC). No camps were identified within the Locality with the closest known camps being located in Ballina; on the Radburn property; Currie Park, Lismore; and Susan Island, Grafton.

Within the study area, potential foraging and roosting habitat exists within Lowland Rainforestand to a lesser degree Camphor Laurel. These plant communities occur in the study area as small, fragmented stands and are considered to be in moderate to poor condition.

To date, critical habitat has not been declared for the Grey-headed Flying Fox, and therefore, the proposed upgrade is unlikely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Potential foraging resources are available for this species in Lowland Rainforest and Camphor Laurel in the study area.The proposed upgrade would remove approximately 7.7 ha and indirectly impact on approximately 20.8 ha of potential habitat for the Grey-headed Flying Fox, which represents less than 1% of

potential habitat in the Locality. Potential habitat for the Grey-headed Flying Fox in the study area was considered to be in moderate to poor condition due to its fragmented and degraded nature. This species is highly mobile, enabling it to easily access habitat outside the development footprint. It is highly unlikely the study area contains core foraging habitat for the Grey-headed Flying Fox. There were no camps detected within the study area.Given the above, it is unlikely that a viable local population of the Grey-headed Flying Fox would be placed at risk of extinction by the proposed upgrade.

Koala *Phascolarctos cinereus*

Description

The Koala is a medium-sized, arboreal marsupial. It spends most of its time in the trees and feeds almost exclusively on Eucalyptus leaves.

Conservation status

The Koala is listed as Vulnerable on the TSC Act.

The species has been recorded in Nightcap National Park to the north-west of the study area. Records also exist on the outskirts of Tyagarah Nature Reserve. South of the study area, records of the species occur from Broadwater Nature Reserve and Bundjalung National Park. The Koala is generally poorly represented in conservation reserves, occurring primarily in forest remnants on private land or within State Forests outside the national parks estate.

Habitat for this species occurs in the study area in Eucalypt Plantations. The vegetation in the study area is considered to be of low to moderate quality, as it exists in isolated, fragmented stands, often surrounded by farmland.

Habitat requirements

The Koala is an arboreal folivore, feeding almost exclusively on the leaves of eucalypt, corymbia and angophora species, although it has been recorded feeding from other tree species including, on occasions, exotic species. The species inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990).

Key Threatening Processes, Recovery and Threat Abatement Plans

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the proposed upgrade that may impact on

potential habitat for the Koala include:

- 'Clearing of native vegetation'; and,
- 'Ecological consequences of high frequency fires'.

A draft Recovery Plan has been prepared for the Koala (NPWS 2003). The aim of the plan is to facilitate the implementation of current legislation in protecting the Koala, especially on a local scale. DECC has listed 29 priority actions to help recover this species. Those relevant to the proposed upgrade include:

- Apply low intensity, mosaic pattern fuel reduction burns in or adjacent to Koala habitat;
- Retain suitable habitat, especially areas dominated by preferred feed-tree species; and,
- Revegetate with suitable feed tree species and develop habitat corridors between populations.

Local and regional abundance

The species has been previously recorded in the northern and eastern part of the Locality. Four records border within 100 m of the study area, the most recent one being from 2005. Within the region, it is moderately common, usually occurring east of the Great Dividing Range.

Location relative to limits of distribution

The Koala has a fragmented distribution throughout eastern Australia, ranging from north-east QLD to the Eyre Peninsula in SA (DEC 2005). In NSW, it mainly occurs on the central and north coasts with some populations in the western region. The study area is not considered at or near the limits of its distribution.

Habitat (Within study area)

Eucalyptus microcorys Tallowood, was recorded in the study area.This is considered a primary feed tree for Koalas on the NSW North Coast (NPWS 2003). *Eucalyptus resinifera* Red Mahogany, is listed as a secondary Koala feed tree for the NSW North Coast (NPWS 2003), and this species was also recorded in the study area.Both species were only recorded at Site 8 during vegetation surveys. The presence of these trees indicates potential habitat for the Koala exists within the study area.Under SEPP 44 "Potential Koala habitat" refers to areas of native vegetation where Koala feed trees constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. The proportion of Koala feed trees within the study area do not constitute 15%, hence, the study area cannot

be considered potential Koala habitat and as such any modification of this vegetation is unlikely to impact this species. It should be noted that all Koala feed trees within the study area have been planted, and do not occur naturally.

Critical Habitat for the Koala has not been declared anywhere in the region.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would involve clearing of potential foraging habitat for the Koala. Potential habitat within the study area is considered to be of moderate to poor quality, and does not meet the criteria to be considered potential Koala habitat as outlined in the Draft Recovery Plan for the Koala. Better quality naturally occurring habitat for this species exists elsewhere in the Locality, particularly in the Moist Sclerophyll Forest closer to the coast.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The proposed upgrade would not remove any potential habitat for the Koala present in the study area.Indirect impacts are not expected. Given the minimal impacts on potential habitat, the proposed upgrade is unlikely to significantly reduce the quality of potential habitat for the Koala within the study area.

Given that potential habitat in the study area is unlikely to be directly impacted, fragmentation is unlikely to increase and mitigation measures would be employed to offset indirect impacts of the proposed upgrade, it is considered unlikely that a viable local population of the Koala would be placed at risk of extinction by the proposed upgrade.

Large-eared Pied Bat *Chalinolobus dwyeri*

Description

The Large-eared Pied Bat is a small to medium-sized bat with long, prominent ears and glossy black fur. The lower body has broad white fringes running under the wings and tail-membrane, meeting in a V-shape in the pubic area. This species is one of the wattled bats, with small lobes of skin between the ears and corner of the mouth.

Conservation status

The Large-eared Pied Bat is listed as Vulnerable the TSC Act and Vulnerable on the EPBC Act.

Less than 30 records of the Large-eared Pied Bat occur scattered across the CMA Northern Rivers Region. The majority of records for this species are within conservation reserves. However, due to a lack of knowledge of the species, it is unknown whether the species is adequately represented in conservation reserves. In the Northern Rivers, it has been recorded within reserves such as Mount Neville Nature Reserve, Sherwood Nature Reserve, Mount Pikapene National Park, Nightcap National Park, Mount Jerusalem National Park and Wollumbin National Park.

Within the study area, potential foraging habitat for the Large-eared Pied Bat occurs in Lowland Rainforest. This plant community occurs in the study area largely as fragmented stands within a rural landscape and is considered to be of low to moderate quality.

Habitat requirements

The Large-eared Pied Bat prefers drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). The species can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1988). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1988).

Key Threatening Processes, Recovery and Threat Abatement Plans

The proposed upgrade would involve the operation of the Key Threatening Process (KTP) ‘Clearing of Native Vegetation’. Clearing of native vegetation results in a loss of foraging habitat for the Large-eared Pied Bat and also results in the loss of habitat for important insect prey items.

Further threats to the species include:

- Clearing and isolation of forest and woodland habitats near cliffs, caves and old mine workings for agriculture or development;
- Loss of foraging habitat close to cliffs, caves and old mine workings from forestry activities and too-frequent burning, usually associated with grazing;
- Damage to roosting and maternity sites from mining operations, and recreational caving activities; and,
- Use of pesticides.

To date, there is no Recovery Plan or Threat Abatement Plan for the Large-eared Pied Bat (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

The DECC lists 17 priority actions to help recover the Large-eared Pied Bat. One of these involves the need to identify the effects of fragmentation on the species in a range of fragmented landscapes such as the farmland/forest interface. For example movement and persistence across a range of fragment sizes.

Local and regional abundance

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. It has not been recorded in the study area or Locality.

Locations relative to limits of distribution

The distribution of the Large-eared Pied Bat extends from the northern border of NSW to the south coast as far inland as the western slopes of the Great Dividing Range. The study area is not situated at the limits of known distribution for this species.

Habitat (within study area)

Potential foraging habitat for the Large-eared Pied Bat occurs within the study area in the Lowland Rainforest. The patches of vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current road and clearing, which have fragmented the vegetation into small degraded patches. The species requires caves for breeding, which are not present in the study area.The species has not been recorded in the study area .

To date, critical habitat has not been declared for this species (DEC 2004c) and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging habitat for the Large-eared Pied. Potential habitat within the study area is considered to be of moderate quality and better quality habitat for this species exists elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest (potential foraging habitat) would be

removed with indirect impacts (edge effects) to a further 3.6 ha. This represents less than 1% of potential habitat within the Locality. Vegetation mapping within the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The Large-eared Pied Bat requires caves for breeding, which are not present in the study area.The study area is therefore unlikely to support a large maternal breeding colony and is unlikely to significantly affect the species' lifecycle.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Large-eared Pied within the study area.The area of potential habitat to be cleared is very small and there is better quality outside the study area.Additionally, the species is highly mobile and the present fragmentation of the potential habitat would not increase as a result of the proposed upgrade. Mitigation measures would also be employed to offset indirect impacts of the proposed upgrade.

The extent to which the species can use fragmented habitat is as yet unknown, but it is unlikely the area provides core habitat that the Large-eared Pied Bat solely relies upon. Therefore, it is considered unlikely that a viable local population of the Large-eared Pied would be placed at risk of extinction by the proposed upgrade.

Large-footed Myotis *Myotis macropus*

Description

The Large-footed Myotis is a microbat with disproportionately large feet which it uses for raking aquatic insects and small fish from the water's surface while in flight. While aquatic insects make up most of its diet, the Large-footed Myotis also forages aerially on moths, beetles and other insects (Churchill 1998). Previously it was thought that up to three species of *Myotis* occurred in Australia, with those in the study area referred to as *M. adversus* (Kitchener *et al*. 1995). A recent genetic study has separated the Australian population from the Indonesian species, and the Australian species is now known as *M. macropus* (Cooper *et al.* 2001). While the DECC profile for the Large-footed Myotis uses the obsolete scientific name, it does

note that the species is now more commonly known as *M. macropus* (DECC 2007).

Conservation status

The Large-footed Myotis is listed as Vulnerable on the TSC Act.

The extent to which this species is represented in conservation reserves is largely unknown, probably due to a lack of surveying. Records are present in the nearby Nightcap National Park (DECC Atlas of NSW Wildlife). Further surveys would be required to determine whether this species is adequately represented in conservation reserves in the region.

Within the study area, potential habitat for this species exists within Lowland Rainforest. In the Locality, these plant communities largely occur as fragmented patches within a rural landscape and as such are considered to be of moderate to low habitat value.

Habitat requirements

The Large-footed Myotis occurs in most habitat types near permanent water bodies, including streams, lakes and reservoirs. They have been located in mangroves, rainforest, swamps and a variety of forest and woodland communities (Churchill 1998). Roosting habitats include tree hollows, caves, among vegetation, and in man-made structures (Churchill 1998).

Key Threatening Processes, Recovery and Threat Abatement Plans

The proposed upgrade would involve the operation of the Key Threatening Process (KTP) 'Clearing of Native Vegetation'. In addition, the Large-footed Myotis is listed as being reliant on tree hollows in the preliminary determination for the proposed KTP declaration for 'Loss of Hollow-bearing Trees'. Clearing of Native Vegetation results in a loss of foraging and roosting habitat for the Large-footed Myotis and also results in the loss of habitat for important insect prey items. The loss of hollow-bearing trees results in the loss of important roosting habitat for this species.

To date, there is no Recovery Plan or Threat Abatement Plan for the Large-footed Myotis (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

Local and regional abundance

The Large-footed Myotis is mainly a coastal species, only occurring further than 100 km inland along some major rivers, like the Murray (DEC 2005,) (Churchill 1998). Its distribution extends the length of the NSW coast (NPWS, Bionet).

This species was recorded in the study area during the current surveys (probable

and possible Anabat identifications, Appendix 5), and has been recorded seven times within 10 km, at the north and north-eastern end of the study area, near the coast. Some of these records represent multiple individuals.

Locations relative to limits of distribution

The study area is not at the limits of the known distribution for this species which follows the coast from eastern South Australia, along the east coast to northern Western Australia.

Habitat (within study area)

Potential habitat for this species occurs within the study area in the Lowland Rainforest. As water sources are a limiting factor when choosing roosting sites and water sources are present in the study area, it is anticipated that most habitats could potentially be utilised for foraging/roosting habitat given the diverse roosting habits of this species. The patches of vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current road and clearing, which have fragmented the vegetation into small degraded patches.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging, roosting and breeding habitat and indirect impacts to water systems for the Large-footed Myotis. Potential habitat within the study area is considered to be of moderate to poor quality, with better quality habitat for this species occurring elsewhere in the surrounding region (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest, (potential habitat) would be removed and 3.6 ha indirectly impacted (edge effects). This represents less than 1% of potential habitat which occurs in the Locality. Vegetation mapping within the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect

impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, indirect impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Large-footed Myotis within the study area.

Given the small area of habitat to be cleared, the presence of better quality habitat outside the study area, the species' high mobility, the suboptimal quality of the potential habitat within the study area, and given that fragmentation would not increase, it is considered unlikely that a viable local population of the Large-footed Myotis would be placed at risk of extinction by the proposed upgrade.

Little Bent-wing Bat *Miniopterus australis*

Description

The Little Bent-wing Bat is a small chocolate brown insectivorous bat with a body length of about 45 mm. The fur is long and thick, especially over the crown and around the neck. The tip of the wing is formed by a particularly long joint of the third finger.

Conservation status

The Little Bent-wing Bat is listed as Vulnerable on schedule 2 of the TSC Act.

Scattered records of the Little Bent-wing Bat occur throughout the Northern Rivers Region. It has been recorded within reserves such as Yuraygir National Park, Bundjalung National Park, Whian Whian State Conservation Area, Border Ranges National Park, Brunswick Heads Nature Reserve, Richmond Range National Park and Mount Pikapene National Park. It is unclear if the species is adequately represented in conservation reserves.

Within the study area, potential foraging habitat for the Little Bent-wing Bat occurs in Lowland Rainforest. In the Locality, this plant community occurs largely as fragmented patches within a rural landscape and is considered to be of low to moderate quality. There is potential for roosting habitat to occur in some man-made structures and tree hollows within the study area .

Habitat requirements

The Little Bent-wing Bat shows a preference for well timbered areas such as moist eucalypt forest, rainforest, Melaleuca swamps and dense coastal banksia scrub (DECC, Churchill 1998). They roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely

vegetated habitats (DECC).

Key Threatening Processes, Recovery and Threat Abatement Plans

The proposed upgrade would involve the operation of the Key Threatening Process (KTP) 'Clearing of Native Vegetation'. Clearing of native vegetation results in a loss of foraging habitat for the Eastern Long-eared Bat and also results in the loss of habitat for important insect prey items. In addition, the species may be marginally affected by the proposed KTP 'Loss of Hollow-bearing Trees' as this would remove limited roosting habitat.

Further threats to the species include:

- Disturbance of colonies, especially in nursery or hibernating caves may be catastrophic;
- Destruction of caves that provide seasonal or potential roosting sites;
- Changes to habitat, especially surrounding maternity caves; and,
- Use of pesticides.

To date, there is no Recovery Plan or Threat Abatement Plan for the Little Bent-winged Bat (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

The DECC lists 24 priority actions to help recover the species. The proposed upgrade does not infringe on these actions.

Local and regional abundance

Scattered records exist throughout the Northern Rivers Region. The species was recorded in the study area during the current surveys (definite Anabat identification, Appendix 5) and has been recorded multiple times (>20) in the Locality. It has been recorded five times approximately 4-5 km of the study area .

Locations relative to limits of distribution

The Little Bent-wing Bat is distributed along coastal north-eastern NSW as far south as Sydney (DECC) and in coastal eastern Queensland. The study area is not at the limit of distribution of the Little Bent-wing Bat.

Habitat (within study area)

Potential foraging habitat for the Little Bent-wing Bat occurs within the study area in Lowland Rainforest. The patches of vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current

road and clearing, which have fragmented the vegetation into small stands. Hollow-bearing trees may provide some roosting habitat for the species. The species requires caves for breeding, which are not present in the study area.The species has been recorded within the study area.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging habitat for the Little Bent-wing Bat. Potential habitat within the study area is considered to be of moderate to poor quality and better quality habitat for this species exists elsewhere in the region (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest (potential foraging habitat) would be removed with indirect impacts to a further 3.6 ha. This represents less than 1% of potential habitat which occurs within the Locality. Vegetation mapping within the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The Little Bent-wing Bat requires caves for breeding, which are not present in the study area.Potential roosting habitat may occur in various man-made structures within the study area.These are unlikely to be affected by the proposed upgrade. The study area is unlikely to support a large maternal breeding colony and is unlikely to significantly affect the species' lifecycle.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Little Bent-wing Bat within the study area.The area of potential habitat to be cleared is very small and there is better quality habitat outside the study area.Additionally, the species is highly mobile and the present fragmentation of the potential habitat would not increase as a result of the proposed upgrade. Mitigation measures would also be employed to offset indirect impacts of the proposed upgrade. Although the species has been recorded in the study area, it

is unlikely the area provides core habitat or that the Little Bent-wing Bat relies solely on this habitat. It is therefore considered unlikely that a viable local population of the Little Bent-wing Bat would be placed at risk of extinction by the proposed upgrade.

Long-nosed Potoroo *Potorous tridactylus*

Description

The Long-nosed Potoroo is a mainly nocturnal, medium sized mammal (up to 1.6 kg). Its fur is greyish-brown and paler underneath, and the snout is long, tapering (Strahan 1995). The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet, which also includes roots, tubers, insects and their larvae and other soft-bodied animals in the soil. The species often digs small holes in the ground in a similar way to bandicoots.

Conservation status

The Long-nosed Potoroo is listed as Vulnerable on the TSC Act and Vulnerable on the EPBC Act. In addition, the Cobaki Lakes and Tweed Heads West population of the Long-nosed Potoroo in the Tweed local government area has been listed as an Endangered Population in Part 2 of Schedule 1 of the TSC Act.

Records of the species within the Northern Rivers CMA are largely restricted to Conservation Reserves: Cottan-Bimbang National Park; Weelah Nature Reserve, New England National Park, Werrikimbe National Park, Dorrigo National Park, Nymboi-Binderay National Park, Clouds Creek State Forest, Guy Fawkes River State Conservation Area, Washpool National Park, Girard State Forest, Whian Whian State Conservation Area, Richmond Range National Park, Tyagarah Nature Reserve, Koreelah National Park, Border Ranges National Park and Gibraltar Range National Park.

Potential habitat for this species occurs in Lowland Rainforest vegetation. The plant communities in the study area are considered to be of low to moderate habitat quality due to their fragmented and disturbed nature.

Habitat requirements

The Long-nosed Potoroo inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The species requires rainforest or vegetation with dense understorey for breeding.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of potential foraging and nesting habitat for this species.

Threats to the Long-nosed Potoroo identified by the DECC include**:**

- Habitat loss and fragmentation from land clearing for residential and agricultural development;
- Predation from foxes, dogs and cats;
- Too frequent fires or grazing by stock that reduce the density and floristic diversity of understorey vegetation; and,
- Logging regimes or other disturbances that reduce the availability and abundance food resources, particularly hypogeous fungi, and ground cover.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified 19 priority actions and lists recovery actions for the species. Those most applicable to the proposed upgrade include:

- Increase habitat via revegetation work and/or establishing corridors to link multiple patches of suitable habitat to expand the effective area of habitat and,
- Protect and maintain habitat, especially dense understorey. Provide linkages across the broader landscape.

Local and regional abundance

There are over 200 records of the Long-nosed Potoroo in NSW, over 100 of which occur within the Northern Rivers CMA (DECC Atlas of NSW Wildlife; Bionet). Although no records exist within the study area, multiple records (>10) are located within 10 km of the study area, north-west of Ewingsdale. One record from 1985 falls within 1 km of the study area.The species has a patchy distribution across its range and there are geographically isolated populations in western Victoria. An Endangered Population of the Long-nosed Potoroo exists approximately 50 km north of the Locality (Cobaki Lakes and Tweed Heads West population of in the Tweed LGA).

Locations relative to limits of distribution

The Long-nosed Potoroo is found on the south eastern coast of Australia, from south eastern Queensland to eastern Victoria and Tasmania, including some

of the Bass Strait islands. In NSW it is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760 mm. The study area is towards the northern end of the species distribution.

Habitat (within study area)

Within the study area, potential breeding and foraging habitat exists within Lowland Rainforest. This plant community in the study area occurs as small, fragmented stands and thus were considered to be in moderate to poor condition.

To date, critical habitat has not been declared for the Long-nosed Potoroo, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Potential foraging and breeding habitat is available for this species in Lowland Rainforest. The proposed upgrade would remove approximately 2.0 ha of suitable habitat for the Long-nosed Potoroo and indirectly impact on 3.6 ha, which represents less than 1% of potential habitat in the Locality. Potential habitat for the Long-nosed Potoroo in the study area was considered to be in moderate to poor condition due to its small and fragmented nature. Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would further fragment potential habitat for the Long-nosed Potoroo.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Long-nosed Potoroos are vulnerable on roads, which they may cross when the road fragments their habitat. The proposed upgrade interferes with one Subregional DEC wildlife corridor and one Subregional Byron Council wildlife corridor. However, as the road crosses part of these corridors underground, it is unlikely to further fragment habitat for this species.

The Long-nosed Potoroo has no special breeding requirements. In NSW, breeding typically occurs in late winter to early summer. While mainly solitary, they are non-territorial and hold small home ranges (2-5 ha), thus it is likely that males and females live alongside one another and therefore do not need to travel far to find mates. The proposed upgrade is unlikely to have a significant impact on the life cycle of this species. It is considered unlikely that a viable local population of the

Long-nosed Potoroo would be placed at risk of extinction by the proposed upgrade.

Magpie Goose *Anseranas semipalmata*

Description

The Magpie Goose is a large, distinctive black and white water-bird with a prominent knob on the head, and orange legs. It has a black head, neck and upper chest, plus rump and tail, with white body and wings. It feeds on grasses, bulbs and rhizomes.

Conservation status

The Magpie Goose is listed as Vulnerable on the TSC Act.

There are not many records of the species in NSW Conservation Reserves. It has been recorded in Kinchega National Park and Cudgen Nature Reserve.

Potential habitat within the study area could exist within small water bodies (e.g. farm dams), rivers, lakes, streams and on cleared grassland. These communities in the study area are considered to be of low to moderate habitat quality due to their modified, fragmented and isolated nature.

Habitat requirements

The Magpie Goose is mainly found in trios or flocks in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges. It uses aquatic or terrestrial habitats when foraging and is often seen walking and grazing on land. Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off. Most breeding now occurs in monsoonal areas and nests are formed in trees over deep water. Breeding is unlikely in south-eastern NSW.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP ‘Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands’. This would involve the removal or modification of potential foraging, roosting and nesting habitat for this species through the crossing of streams and creeks (including Emigrant Creek and Byron Creek) and disturbance to surrounding vegetation. However, impacts on the waterways are expected to be minimal as larger watercourses would be crossed using bridges.

Threats to the Magpie Goose identified by the DECC include**:**

- Inappropriate hydrological regimes of wetland habitats through drainage of swamps, ponds, dams and other wetlands for agricultural and other human purposes;
- Degradation of habitat through water pollution (e.g. salinity, chemicals, eutrophication);
- Modification of habitat and nest loss from trampling and overgrazing;
- Predation on eggs and goslings; and,
- Too-frequent burning of wetlands.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified recovery strategies including 15 priority actions to recover the species in NSW. Those most relevant to the proposed upgrade include:

- Community and land-holder liaison/ awareness and/or education: Educate landowners on the importance of vegetated wetlands for Magpie Geese, and on threats to Magpie Geese (i.e. frequent fires, feral animals, altered hydrology, dogs, grazing) and ways to mitigate threats;
- Prepare EIA guidelines to help consent authorities adequately assess the impact of developments;
- Avoid placing powerlines over or near wetlands/ nest sites; and,
- Restore natural hydrological regimes to freshwater wetlands, and maintain existing hydrological regimes. Do not fill or drain wetlands.

Local and regional abundance

The Magpie Goose is still relatively common in Australia's northern tropics. The species had suffered a range contraction from south-east Australia by the early 1900s, primarily due to loss of wetland habitat (e.g. drainage and overgrazing of reed swamps used for breeding (DECC) and hunting (Nye 2007). Since the 1980s there have been an increasing number of records in central and northern NSW (DECC) following the species protection in the 1930s and successful reintroductions. However, populations are unlikely to return to their former numbers in the south-east as management of water resources has greatly reduced areas of breeding habitat and drought refuges (Nye 2007).

There are over 230 records of the species within NSW (Bionet; DECC Atlas of NSW Wildlife) and more than 80 of these occur in the Northern Rivers Region. The Magpie Goose has been recorded once (5 individuals) within the Locality, south of

the study area near the Richmond River.

Locations relative to limits of distribution

The current distributional boundary of the Magpie Goose is now in south-eastern Queensland and the northern coast of NSW (Nye 2007). In this way, the Locality is at the limits of the species' southern distribution.

Habitat (within study area)

Although there are no records of the Magpie Goose within the study area, there is one record of the species within the Locality. The species could use small water bodies (e.g. farm dams), rivers, lakes and streams and cleared grassland as foraging habitat within the study area.Suitable plant communities in the study area occur as small, fragmented stands and thus were considered to be in moderate to poor condition. No preferred breeding habitat in the form of SEPP 14 Wetlands occurs in the study area.

To date, critical habitat has not been declared for the Magpie Goose.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Although there is potential habitat for this species within the study area, it occurs as modified, small, fragmented stands along creeks, streamlines and on agricultural land and was considered to be in moderate to poor condition. The proposed upgrade would remove less than 1% of waterside and grassland habitat in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect impacts.

Given the activities of the Magpie Goose centre on larger wetlands, which are absent from the study area, it is unlikely that individuals of this species rely wholly on potential habitat within the study area.The Magpie Goose's high mobility would enable it to easily access better quality habitat outside the development footprint. Due to the minimal impacts expected and the poor quality of potential habitat, it is considered unlikely that a viable local population of the Magpie Goose would be placed at risk of extinction by the proposed upgrade.

Marbled Frogmouth *Podargus ocellatus*

Description

The Marbled Frogmouth is a small to medium sized frogmouth with rich brown plumage delicately flecked and peppered with black and white. Two widely separated races of Marbled Frogmouth occur with one confined to Cape York Peninsula (*marmoratus*) and the other found between Gladstone in south-east Queensland and Lismore in north-east NSW (*plumiferus*).

Conservation status

The Marbled Frogmouth is listed as Vulnerable on the TSC Act.

The Marbled Frogmouth has been recorded within NSW Conservation Reserves such as: Wilson Nature Reserve; Broken Head Nature Reserve; Andrew Johnston Big Scrub Nature Reserve; Nightcap National Park Mount Jerusalem National Park; Border Ranges National Park; Mount Warning National Park; Richmond Range National Park; and also in Richmond Range State Forest.

Potential habitat within the study area exists within Lowland Rainforest. This plant community in the study area is considered to be of low to moderate habitat quality due to its fragmented and degraded nature.

Habitat requirements

The Marbled Frogmouth prefers subtropical rainforest or the ecotone between rainforest and eucalypt forest, spending most time in deep, wet, sheltered gullies frequently containing stands of Bangalow Palms. Less frequently it occurs in higher elevation temperate rainforests and wet eucalypt forest with a well-developed rainforest understorey. The species is permanently territorial and sedentary. They may forage along roads through forest (Higgins 1999).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP ‘Clearing of Native Vegetation’. This would involve the removal of potential foraging, roosting and nesting habitat for this species and its prey.

Further threats to the species include:

- Isolation of patches of habitat due to frequent burning of connecting forest;
- Clearing, fragmentation and isolation of rainforest and wet eucalypt forest

from agricultural and forestry activities;

- Opening of the canopy and promotion of dense understorey growth caused by timber harvesting; and,
- Invasion of habitat by weeds following disturbance.

To date no Recovery Plan or Threat Abatement Plan has been prepared for the Marbled Frogmouth. The DECC has identified 11 priority actions and lists recovery actions for the species. Those that are relevant to the proposed upgrade include:

- Liaise with relevant landholders, community groups and managers to protect, rehabilitate, enlarge and reconnect habitat. Raise awareness of palm stands and vines as habitat;
- Prevent lowland rainforest habitat loss and fragmentation. Expand and reconnect habitat;
- Protect known and potential habitat from clearing, fragmentation and isolation. Reconnect patches of known habitat with wide corridors including streamside areas;
- Replace Camphor Laurel with native rainforest species;
- Nominate core areas in Mt Warning and Focal Peak Calderas as critical habitat. Prioritise acquisition of lowland subtropical rainforest remnants in far north-eastern NSW. Manage for conservation;
- Monitor core populations - including Nightcap, Koonyum and Burringbar Ranges, Richmond Range, Tweed Range. Also peripheral populations such as Wilsons Park NR;
- Determine home range requirements, seasonal measurements, breeding requirements and success, dispersal, assess likely response to climate change. Compile, store and maintain data on biology and ecological requirements of this species, particularly core populations and outliers; and,
- Report any records, particularly those based on calls, from outside the accepted range to the DEC.

Local and regional abundance

Its NSW distribution extends from the north-east, west to the upper Clarence River and it is generally rare. In NSW, there are nearly 200 records of the Marbled Frogmouth (DECC Atlas of NSW Wildlife; Bionet). All records fall within the CMA Northern Rivers Region. One record is located in Ballina LGA and two

records within the Byron LGA. Multiple records exist within Wilson Nature Reserve, Lismore. It has been recorded twice within the 10 km search area.

Locations relative to limits of distribution

Within NSW, the *plumiferus* race of the Marbled Frogmouth is confined to the Northern Rivers Region (Higgins 1999). Within the Clarence Lowlands CMA sub-region where the species is known to occur, it is restricted to north of Ballina township. It is considered uncommon and sedentary.

The species is limited in its distribution by its preference for subtropical rainforest habitat. The study area is towards the southern end of the species' limited distribution both in NSW and Australia.

Habitat (within study area)

Although the Marbled Frogmouth has not been recorded within the study area, there is one record within the Locality in Broken Head Nature Reserve**.** Potential habitat within the study area exists within Lowland Rainforest. This habitat occurs in the study area as small, fragmented stands. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species composition.

To date, critical habitat has not been declared for the Marbled Frogmouth, although the Marbled Frogmouth is listed as a species commonly associated with Lowland Rainforest. The lowland population (*plumiferus*) is thought to have declined because of the clearing of Lowland Rainforest (Higgins 1999).

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The Marbled Frogmouth is permanently territorial, has a small range within Australia and NSW and is restricted by specific habitat preferences. While it has not been recorded within the study area, there are three records of the species within the Ballina and Byron LGA's with one occurring in the Locality. The proposed upgrade would remove approximately 2.0 ha of Lowland Rainforest and indirectly impact on a further 3.6 ha. This figure represents less than 1% of moist forest and rainforest (including disturbed habitat) in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for the Marbled Frogmouth occurs as small and fragmented patches and thus was considered to be of low to moderate quality. It is unclear if the Marbled Frogmouth can successfully utilise fragmented and/or disturbed habitat. They are particularly susceptible to rainforest clearing and fragmentation and occupy small home ranges (5-18 ha) (Higgins 1999). It is unlikely the species relies solely on the limited and fragmented rainforest vegetation in the study area and therefore it is unlikely the removal of this potential foraging habitat would place a local viable population of the Marbled Frogmouth at risk of extinction.

Masked Owl *Tyto novaehollandiae*

Description

The Masked Owl is a medium-sized owl to 40 - 50 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc that is encircled by a dark border (DEC 2006b). The species exists in several colour forms, with a wide variation in plumage (Higgins 1999).

Conservation Status

The Masked Owl is listed as Vulnerable on Schedule 2 of the TSC Act.

The Masked Owl is uncommon but widely distributed throughout its range in NSW and occurs mostly within conservation reserves and state forests, although there are increasing numbers of records on private land (DEC 2006b). The majority of broad scale systematic surveys for this species have been undertaken in conservation areas rather than private lands (DEC 2006b).

Known and potential habitat for the Masked Owl in the study area mainly occurs in Lowland Rainforest and in the species may also forage in open areas, such as cleared or partly cleared farmland and grassland. Patches of Lowland Rainforest in the study area are highly fragmented and disturbed.

Habitat requirements

The Masked Owl inhabits a diverse range of wooded habitats (e.g. eucalypt forests and woodlands) that provide tall or dense mature trees with hollows suitable for nesting and roosting, and nearby open areas for foraging (Higgins 1999). It mainly occupies dry eucalypt forests on the tablelands and western slopes and the undulating wet-dry forests of the coast (DEC 2006b). They are regularly found in disturbed habitats, such as farmland with remnant trees and selectively logged forest (Higgins 1999). The Masked Owl feeds mostly on small to medium sized terrestrial mammals, often hunting along the edges of forests, including roadsides (Higgins 1999). The species roosts and breeds in moist eucalypt forest gullies, using large tree hollows (>40 cm diameter) or sometimes caves for nesting

(DECC). A pair is faithful to a traditional nesting hollow, but may also use alternative hollows in the breeding territory in different years (DEC 2006b). Pairs have a large home range of 500 to 1000 hectares (DECC).

Key Threatening Processes and Threat Abatement Plans

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of two KTPs known to affect the Masked Owl: 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and the proposed KTP 'Loss of Hollow Bearing Trees'. In addition, the Masked Owl may be affected by the KTPs 'Predation by feral cats' and 'Predation by the European Red Fox'. The KTP 'Human Caused Climate Change' may also have impacts on this species in the longer term (DEC 2006b). Further threats to the Masked Owl identified by the DECC include:

- Loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future;
- Clearing of habitat for grazing, agriculture, forestry or other development;
- A combination of grazing and regular burning, through the effects on the quality of ground cover for mammal prey, particularly in open, grassy forests;
- Secondary poisoning from rodenticides; and,
- Being hit by vehicles.

To date, no Threat Abatement Plan exists for the Masked Owl.

A Recovery Plan has been prepared for this species (DEC 2006b). In addition, the DECC has listed recovery strategies and 21 priority actions to help recover this species, some of which include:

- Retain and protect stands of native vegetation, especially those with hollow-bearing trees;
- Retain hollow-bearing trees as well as large, mature trees that will provide hollows in the future;
- Encourage CMAs to invest in actions that actively manage and/or conserve large forest owl habitat as part of their Catchment Action Plans;
- Prepare environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess impacts of

developments on the Masked Owl;

- Use records of concurrence and licence conditions to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the Masked Owl outside conservation reserves and State forests;
- Encourage private landholders to undertake management options to conserve and/or actively manage forest owl habitat; and,
- Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.

Local and Regional Abundance

The Masked Owl has an extensive distribution from northeast Queensland to eastern South Australia, with subspecies in Tasmania and northern Australia. It also occurs in southwest Western Australia. In NSW the species occurs from the coast to the western plains. The species is uncommon to rare throughout its range, but is most abundant in coastal areas.

The Masked Owl was recorded in the study area during the current surveys and has been recorded six times in the Locality.

Locations relative to limits of distribution

The Masked Owl is widespread across NSW (excluding the most arid north western corner). The study area is not at or near the limit of distribution of the Masked Owl.

Habitat (within study area)

Potential foraging habitat for the Masked Owl occurs within the study area in Lowland Rainforest and in nearby open areas. The Masked Owl was recorded in Lowland Rainforest within the study area during the current surveys. Patches of this plant community in the study area are small, fragmented and degraded. The study area does not contain trees with sufficiently large hollows for nesting.

To date, critical habitat has not been declared for this species.

Likely impacts on long-term viability and rate of extinction of threatened species

The Masked Owl was recorded in Lowland Rainforest in the study area during the current surveys and there are recent records of the species in the Locality. Approximately 2.0 ha of Lowland Rainforest, potential foraging habitat for the species, would be removed with a further 3.6 ha potentially affected by

indirect impacts. Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Along with many other species, the clearing of forests and woodland (typically for agriculture) has reduced the amount of habitat available for the Masked Owl in NSW (DEC 2006b). However, less than 1% of moist forest and rainforest (including disturbed areas) in the Locality will be removed by the proposed upgrade. Larger areas of better quality habitat occurs within conservation reserves and state forests and to a lesser extent on private forest lands in the region. Given the small size of the habitat in the study area, the large amount of potential habitat in the Locality, and the species' large home range size, it is highly unlikely that the Masked Owl would rely solely on this habitat.

The Masked Owl requires large hollows in living or dead trees for breeding and nesting, which do not occur in the study area.It is unlikely the study area provides breeding habitat for the Masked Owl.

Masked Owl mortality from road kills is high (DEC 2006b) possibly because the species frequently forages along roadsides in forested areas. However, given that the majority of the proposed upgrade occurs along or near an existing road, it appears unlikely that existing levels of road mortality would significantly increase.

Given the small area of habitat to be removed, the already fragmented nature of the landscape and the species' high mobility, it is unlikely the proposed upgrade would fragment or isolate potential habitat for the Masked Owl. It is considered unlikely that that a viable local population of the Masked Owl would be placed at risk of extinction by the proposed upgrade.

Mitchell's Rainforest Snail *Thersites mitchellae*

Description

Mitchell's Rainforest Snail is a large, native snail with a triangular shell, deep chestnut to black in colour with two prominent yellow bands. The body is black with a lighter dorsal stripe. The shell can be up to 55 mm in width and has the appearance of satin when held up to the light.

Conservation status

Mitchell's Rainforest Snail is listed as Endangered under the TSC Act and

Critically Endangered under the EPBC Act.

The species has been recorded north of the study area in Tyagarah Nature Reserve on the coast, and a population occurs on Stott's Island. It is not adequately represented in conservation reserves.

Potential habitat for Mitchell's Rainforest Snail occurs in the study area within Lowland Rainforest. This vegetation type is listed as an Endangered Ecological Community, but is considered to be of low to moderate habitat quality due to the small size of the patches and their isolation.

Habitat requirements

Mitchell's Rainforest Snail is found exclusively in lowland rainforests and swamp sclerophyll forest with a rainforest understorey (NSW National Parks and Wildlife Service 2001). It is typically found in leaf litter on the forest floor, or occasionally under bark (NPWS 2005). It tends to occur on the margins of coastal wetlands (NSW National Parks and Wildlife Service 2001). Key habitat components for this species are a well-developed leaf-litter layer for feeding and breeding, and an intact forest canopy, maintaining a moist microclimate (NSW National Parks and Wildlife Service 2001).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes as listed in the TSC Act:

- 'Clearing of native vegetation' – The proposed upgrade would remove 2.0 ha of Lowland Rainforest, which is potential habitat for Mitchell's Rainforest Snail;

- Exotic vines and scramblers – Invasion of exotic vines and scramblers can alter the abundance and diversity of plant-dwelling invertebrates. The proposed upgrade is not likely to increase the threat of exotic vines and scramblers in the study area, as the patches of vegetation within the Study Site are already highly disturbed and impacted by edge effects. Weed control works should be detailed in a Vegetation Management Plan; and,

- *Lantana camara* – Lantana has been identified as a threat to Lowland Rainforest Communities. The proposed upgrade is not likely to increase the threat of *Lantana camara* in the study area, as the patches of vegetation within the Subject Site are already highly disturbed and impacted by edge effects. Weed control works should be detailed in a Vegetation Management Plan.

- 'Infection of native plants by *Phytophthora cinnamomi*' – causing dieback,

which damages the delicate microclimate and foraging resources this species requires.

No Threat Abatement Plan has been prepared for this species to date. A Recovery Plan for this species has been prepared. The objectives of the plan are to assist in the identification of potential habitat and additional populations of Mitchell's Rainforest Snail, to improve the protection of known populations of this species, and to encourage community involvement in its recovery.

The DECC has prepared a list of priority actions to aid in the recovery of this species. Those actions relative to the proposed upgrade are listed below:

- Provide advice to relevant agencies and stakeholder groups on the conservation requirements and the location of known populations and potential habitat; and,

- Potential habitat (i.e. all Lowland Rainforest and Swamp Sclerophyll Forest remnants and vegetated remnants) within 50 m of SEPP 14 coastal wetlands be protected from clearing or development in the relevant LEPs.

Local and regional abundance

Within the wider region, populations of this species have been found at Stott's Island Nature Reserve near Murwillumbah and Cumbebin Wetland at Byron Bay (NSW National Parks and Wildlife Service 2001). The species is rare in both the Locality and the region.

There are 19 records of Mitchell's Rainforest Snail within the Locality, all in two vegetation patches near the coast within 8 km east of the study area.

Location relevant to limits of distribution

The species has a restricted range, reflecting its specialised habitat requirements. It is restricted to the coastal plain between the Richmond and Tweed Rivers (NSW National Parks and Wildlife Service 2001). The most southern records are those within the Locality, thus the study area is at the limits of the known distribution for this species.

Habitat (within study area)

Potential habitat for this species in the study area occurs within Lowland Rainforest, although all the records are from low lying areas near the coast. This vegetation type in the study area is considered to be of poor quality due to the small size of the patches, their isolation and degraded nature. This species has often been recorded in forest remnants (NSW National Parks and Wildlife Service 2001).

Critical habitat has been declared for this species at Stott's Island Reserve near Murwillumbah. This area is not within the study area or Locality.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest would be removed by the proposed upgrade with indirect impacts to a further 3.6 ha. This represents less than 1% of potential habitat occurring within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The breeding biology of the Mitchell's Rainforest Snail is poorly known, with breeding behaviour only being observed once, when a clutch of eggs was laid just under the leaf litter on the rainforest floor {NPWS, 2001 #627}. Based on this observation and ecology of similar snails it is believed that a well-developed leaf litter layer (for foraging and breeding) and an intact forest canopy (to maintain a suitable microclimate) are key breeding habitat requirements (NPWS 2001b). The Lowland Rainforest remnants within the study area contain a moderately developed leaf litter layer and a generally intact canopy, although the small sizes of the fragments reduces the protection of their microclimate and connection with known populations.

If Mitchell's Rainforest Snail occurs within the study area, the action would have the potential to disrupt the breeding cycle of a population of this species. However, there is no evidence of an existing or historic population within the study area and, given the habitat requirements of the species and location of known populations, it appears unlikely that the species would be utilising the study area.

Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would further fragment potential habitat for the species. Critical habitat has been declared for this species at Stott's Island Reserve near Murwillumbah, but the proposed upgrade would not interfere with that critical habitat.

Approximately 2.0 ha of Lowland Rainforest potential foraging and breeding habitat for this species would be cleared for the proposed upgrade. The species is critically endangered, relatively immobile, and its limited range is at its southern limit within the study area.It should be noted that the species is small and slow moving, not requiring large tracts of intact habitat and it is probably unable to disperse from an area it inhabits. However, due to the high extent of modification

and degradation and small patch size of the habitat within the study area, it is considered unlikely that a viable local population, if it is present, would be placed at risk of extinction by the proposed upgrade.

Pouched Frog *Assa darlingtoni*

Description

The Pouched Frog is a small frog reaching approximately 20 mm in length (DEC 2005o). It is pinkish-brown to red in colour, usually with darker patches on the head and body. The belly is cream or white and the throat mottled. There is a pink spot at the base of each arm. It occurs in north-eastern NSW and south-eastern QLD (Barker *et al.* 1995).

Conservation status

The Pouched Frog is listed as Vulnerable on the TSC Act.

This species has been recorded in Nightcap National Park, Goonengerry National Park and Mount Jerusalem National Park to the north-west of the study area.It is unknown whether this species is adequately represented in conservation reserves.

This species does not require standing water to breed, as tadpoles are raised in the hip pouches of the male (Barker *et al.* 1995). Within the study area, potential habitat occurs within Lowland Rainforest. Rainforest vegetation types in the area are considered to be of low to moderate habitat quality due to their fragmented and degraded nature.

Habitat requirements

The Pouched Frog occurs in rainforest and wet sclerophyll forest. It is usually found in mountainous areas at an elevation of above 800 m (DEC 2005o). The species spends most of its time in damp leaf litter or under rocks and rotting logs (DEC 2005o). It does not require water to breed, as eggs are deposited on the ground in a gelatinous mass. After hatching, the tadpoles move to the pouches at the hips of the male frog, where they remain until they have morphed.

Key Threatening Processes, Recovery and Threat Abatement Plans

Key threatening processes which are identified under Schedule 3 of the TSC Act as affecting the Pouched Frog are:

- Clearing of native vegetation;
- Removal of dead wood and dead trees;

- Bushrock removal; and,
- Ecological consequences of high frequency fires.

To date, there is no Recovery Plan or Threat Abatement Plan for the Pouched Frog.

Local and regional abundance

This species has been recorded predominantly on the inland ranges, such as the Nightcap Range. It has been recorded once in the Locality, approximately 8 km west of the study area.It has not been recorded in the study area.

Locations relative to limits of distribution

The Pouched Frog has a patchy distribution in north-eastern NSW and south-eastern QLD, with five isolated populations: Dorrigo Plateau, Gibraltar Range, Border Ranges and two in south-east QLD (DEC 2005o). Although it is generally restricted to the Northern Rivers in NSW, it has been recorded as far south as Dorrigo. The study area is therefore not close to or at the limits of distribution for this species.

Habitat (Within study area)

Potential habitat for the Pouched Frog occurs within the study area in the Lowland Rainforest although all of the study area lies below 800 m. This habitat provides potential foraging, sheltering and breeding sites. The patches of vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current road and clearing, which have fragmented the vegetation into small stands.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential habitat; removal of bush rock and dead wood used for sheltering; and, may alter the natural fire regime, causing more frequent fires that would damage the leaf litter layer required for the Pouched Frog. Potential habitat within the study area is considered to be of moderate to poor quality and better quality habitat for this species exists elsewhere in the region, particularly at higher elevations to the west.

Approximately 2.0 ha of Lowland Rainforest (potential habitat) would be removed, with indirect impacts to a further 3.6 ha. This represents less than 1% of potential habitat which occurs within the Locality. Vegetation mapping of the Locality

includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, impacts are unlikely to significantly reduce the quality of potential habitat for the Pouched Frog within the study area .

The species has no special breeding requirements and can reproduce in the same habitat as it forages and shelters in. It is unlikely the small, disturbed patches of rainforest present in the study area contain core breeding sites, thus it is unlikely the proposed upgrade would significantly affect the life-cycle of the Pouched Frog.

The area of sub-optimal potential habitat to be cleared is very small and there is better quality habitat outside the study area.The present fragmentation of potential habitat would not increase as a result of the proposed upgrade. Mitigation measures would also be employed to offset indirect impacts of the proposed upgrade. It is therefore considered unlikely that a viable local population of the Pouched Frog would be placed at risk of extinction by the proposed upgrade.

Red-backed Button-quail *Turnix maculosa*

Description

The Red-backed Button-quail is a small, ground-dwelling bird, buff-breasted with a red nape and shoulder patch, and buff on the undertail-coverts. In flight, there is a sharply defined buff panel on the central inner wing-coverts that is diagnostic. Another diagnostic feature is the fine, yellow bill. It is nocturnal and crepuscular (Marchant and Higgins 1993b).

Conservation status

The Red-backed Button-quail is listed as Vulnerable on the TSC Act.

In the wider region, the species has been recorded south of the study area in Bundjalung National Park. Records are generally sparse as this species is shy and rarely seen. It is not considered to be adequately represented in conservation

reserves, although it is probably under-recorded.

Potential habitat for this species is present in the study area in grassland vegetation, particularly alongside water. The vegetation in the study area is considered to be of low to moderate habitat quality due to its modified and fragmented nature.

Habitat requirements

Red-backed Button-quail inhabit grasslands, woodlands and cropped lands of warm temperate areas that annually receive 400 mm or more of summer rain (Marchant and Higgins 1993b). The species apparently prefers sites near water, including grasslands and sedgelands near creeks, swamps, springs, and wetlands (Marchant and Higgins 1993b). Red-backed Button-quail prefer to breed in dense grass near water (Marchant and Higgins 1993b).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes as listed in the TSC Act:

- 'Clearing of native vegetation';
- 'Predation by feral cats' – this species is ground-dwelling and tends to freeze when in danger, making it vulnerable to predation by introduced predators;
- 'Predation by the European red fox'; and,
- 'Ecological consequences of high frequency fire' – this species is dependent on grasslands, which are vulnerable to disruption by unnatural fire regimes. However, the proposed upgrade is unlikely to increase the frequency of fires.

The Threat Abatement Plan relevant to the Red-backed Button-quail is the Fox Threat Abatement Plan. The aim of this plan is to reduce the impact of the European Red Fox on native animals and generally conserve biodiversity. The plan lists medium and high priority threatened species, and high priority geographic areas for which fox control should be focused. Neither the Red-backed Button-quail nor the study area is mentioned as a priority in the Fox Abatement Plan.

The DECC have prepared a list of priority actions to aid in the recovery of this species. The actions relevant to the proposed upgrade are listed below:

- Prevent drainage or destruction of key wetlands or habitats; and,
- Protect and restore Red-backed Button-quail habitats. The species prefers sites near water, including grasslands and sedgelands near creeks, swamps and springs, and wetlands.

Local and regional abundance

There are no records of the Red-backed Button-quail within the Locality. Records are infrequent in the broader region. The species is shy and rarely recorded, making it difficult to judge the abundance. In NSW, it is most common in the Northern Rivers region, but is uncommon throughout its range.

Location relative to limits of distribution

The Red-backed Button-quail is widespread in Australia, occurring in northern WA, northern NT, northern and eastern QLD, but the distribution is interrupted in several places. In NSW, the species occurs generally in the Northern Rivers, but has been recorded as far south as Sydney. However, records south of the Manning River tend to be very old. The study area is not considered to be at or near the limits of known distribution for this species.

Habitat (within study area)

This species is reliant on dense, tall grasses, preferably close to water. Potential habitat may occur in the study area alongside rivers and creeks, and possibly in farmland if the grass is long enough. Potential habitat in the study area is considered to be of poor to moderate quality due to fragmentation, isolation, and previous disturbance.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Although there is potential foraging habitat for this species within the study area, it occurs as small, fragmented stands along creeks and streamlines or on agricultural land and was considered to be in moderate to poor condition. It should be noted that this habitat is highly disturbed agricultural land and is therefore poor quality habitat for the Red-backed Button-quail. It can therefore be estimated that the amount of potential habitat for the Red-backed Button-quail to be impacted by the proposed upgrade represents a small percentage of the amount of potential habitat available in the Locality. The proposed upgrade would remove less than 1% of cleared grassland/pasture and waterside habitat in the Locality and no SEPP 14 habitat.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls, the Vegetation Management Plan and the bridging of major watercourses will minimise indirect impacts.

The breeding biology of the Red-backed Button-quail is poorly known, but it is believed that breeding occurs from October to February in northern NSW (Marchant and Higgins 1993b). This species nests near water, which is where its preferred foraging habitat is. It is unlikely the proposed upgrade would have a significant impact on the life-cycle of this species given that only a small amount of available breeding habitat in the Locality will be impacted.

Given the already fragmented and disturbed nature of the landscape, it is unlikely the proposed upgrade would fragment potential habitat for the Red-backed Button-quail further. Potential habitat in the study area is highly disturbed agricultural land and is considered to be poor quality habitat. In addition, this vegetation type is abundant in the Locality and throughout the region and the proposed upgrade would remove only a small proportion of this vegetation type. It is therefore considered unlikely that a viable local population of the Red-backed Button-quail would be placed at risk of extinction by the proposed upgrade.

Red Goshawk ***Erythrotriorchis radiatus***

Description

The Red Goshawk is a large, long-winged hawk. Its flight is very fast with strong wing beats. When soaring, a distinctive underwing pattern of rust-red on the wing edges contrasting with heavy white bars is visible.

Conservation status

The Red Goshawk is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act.

The species has been recorded in Boat Harbour Nature Reserve, Tuckean Nature Reserve, Bundjalung National Park, Braemar State Forest and Nightcap National Park. Although the species has been recorded in many of the conservation reserves in the region, it is unlikely that the species is adequately represented in these, as it is considered that the NSW population is at a critically low level (DEC 2004i).

Potential habitat for the species occurs within the study area along tree-lined waterways such as creeks and streams and in adjacent agricultural grassland, as the Red Goshawk prefers to forage on floodplains interspersed with dense forest and open woodland. These vegetation types include Lowland Rainforest within the study area.These plant communities in the study area are considered to be of low to moderate habitat quality due to their fragmented and disturbed nature.

Habitat requirements

The Red Goshawk occurs in forests and woodland in north-eastern and north

Australia (Slater *et al.* 2003). It is most often seen in association with northern woodlands, tree-lined waterways, crossing grasslands or shrublands (Olsen 1995). This species has a very large territory, perhaps 120-200 km^2 (Olsen 1995).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes applicable to the proposed upgrade:

- 'Clearing of native vegetation' – Native vegetation, especially riverside vegetation and floodplain forests, provides essential habitat for this species; and,

- 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands' – This species requires habitats associated with healthy watercourses.

The DECC has prepared a Recovery Plan for the Red Goshawk. The aim of this plan is to identify and protect habitat being used by Red Goshawks, especially nesting areas, and to raise awareness of the plight of the Red Goshawk, improve communication for conservation efforts between NSW and QLD, and review the legal status of the species. The DECC recommends the following priority actions relevant to the proposed upgrade to aid in the recovery of this species:

- Develop EIA guidelines to ensure consultants and consent authorities adequately assess potential impacts to this species from development and other proposed activities – the species was targeted during field surveys, but not detected.

There is currently no Threat Abatement Plan relevant to this species.

Local and regional abundance

There are two records of the Red Goshawk within the Locality. The species is probably moderately common in the Locality and region, given the large size of territories, the critically low population in NSW, and naturally low densities of breeding pairs. Records in the Locality are close to the Richmond River south of the study area.

Within the broader region, the species has been recorded in several conservation reserves in the north-east of NSW.

Locations relative to limits of distribution

This species has been recorded from southern and central NSW in the past (NPWS 2002b), although it has experienced a range contraction of approximately 500 km to

the north in NSW (Blakers *et al.* 1984). This puts the study area closer to the southern limits of the known distribution of this species, but the study area is still considered to be comfortably within the limits of this species' current distribution.

Habitat (within study area)

The study area contains some habitat preferred by this species in Lowland Rainforest, where it occurs along waterways. These vegetation types are present only in small, isolated pockets in the study area, and are of low quality and limited use to a wide-ranging species like the Red Goshawk. Potential habitat also occurs across the grasslands. The presence of several records in the area and wider region suggest that better habitat is available nearby, particularly in the conservation reserves, which contain larger tracts of vegetation close to larger watercourses.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Forest would be removed from the study area with indirect impacts affecting 3.6 ha of habitat. This represents less than 1% of potential Lowland Rainforest habitat occurring within the Locality. However, only patches bordering waterways is considered suitable habitat for the Red Goshawk and therefore these figures are likely to be smaller. Less than 5% of cleared land in the Locality occurs in the study area, suggesting there are much larger areas of grassland in the surrounding area which could act as potential foraging habitat.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The Red Goshawk has no special breeding requirements. In northern NSW, it lays 1-2 eggs in spring, the young growing slowly (Olsen 1995). Breeding efforts by this species are becoming rarer in northern NSW (NPWS 1999e), but it is unknown why. It is likely clearing of native vegetation is largely responsible for the reduced breeding effort in NSW. Due to the already disturbed and fragmented nature of the potential habitat in the study area, it is unlikely it contains core breeding habitat for the Red Goshawk, therefore, the proposed upgrade is unlikely to affect the life cycle of this species.

Given the already fragmented nature of the landscape, and the high mobility of the species, it is unlikely the proposed upgrade would further fragment potential habitat for the Red Goshawk. Considering the large territory size of this species, its high mobility and the poor quality of habitat within the study area, it is unlikely the

proposed upgrade would place a viable local population of the Red Goshawk at risk of extinction.

Rose-crowned Fruit-dove *Ptilinopus regina*

Description

The Rose-crowned Fruit-dove is a small, rainforest pigeon very similar to the Superb Fruit-dove. The adults have a deep pink cap bordered by yellow on the forehead and crown.

Conservation status

The Rose-crowned Fruit-dove is listed as Vulnerable on Schedule 2 of the TSC Act.

Due to the scattered and scarce records for this species, it is unknown whether it is adequately represented in conservation reserves within the region. Most records fall outside of conservation reserves. It has been recorded nearby in Nightcap National Park.

Within the study area, potential habitat for the species occurs in Lowland Rainforest and Camphor Laurel. In the Locality, this plant community largely occurs as fragmented patches within a rural landscape.

Habitat requirements

The Rose-crowned Fruit-dove occurs in rainforest and similar closed forests where it forages on fleshy fruits from a variety of trees. It prefers large expanses of undisturbed forest, but can be found in very small remnants (Higgins and Davies 1996). It has been recorded feeding in isolated fruit trees and sometimes in gardens (Higgins and Davies 1996). It is considered partially nomadic, following the fruiting patterns of trees within a local area (Higgins and Davies 1996). They are also known to use stands of Camphor Laurel as a source of food (DEC 2005).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP ‘Clearing of Native Vegetation’. This would involve the removal of feed trees and potential roosting and nesting habitat for this species.

To date, there is no Recovery Plan or Threat Abatement Plan for the Rose-crowned Fruit-dove.

Local and regional abundance

This species is wide-spread in the north-east of NSW, found from the coast inland to the eastern slopes of the Great Dividing Range. It occurs as far south as the Hunter Region and Sydney on occasion.

This species has been recorded multiple (>20) times in the Locality. Three records occur within 50 m of the study area and another five are located within 4 km.

Locations relative to limits of distribution

The Rose-crowned Fruit-dove is widespread in Australia, occurring in the NT, northern WA, north and eastern QLD, and eastern NSW to Sydney. The study area is not at the limits of distribution of this species.

Habitat (Within study area)

Habitat within the study area is within Lowland Rainforest and Camphor Laurel. The species has been recorded within the study area.Habitat for the species in the study area occurs as small, fragmented patches. These patches of vegetation are considered to be in moderate to poor condition, due to their small fragmented nature and modified structure and species composition, as a result of impacts from the current road and previous land clearing for agriculture.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging, roosting and breeding habitat for the Rose-crowned Fruit-dove. Potential habitat within the study area is considered to be of moderate to poor quality and better quality habitat for this species exists elsewhere in the Locality (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 7.7 ha of Lowland Rainforest and Camphor Laurel dominated forest (potential habitat) would be removed by the proposed upgrade. This represents less than 1% of potential habitat that occurs within the Locality. Vegetation mapping within the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation

of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, indirect impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Rose-crowned Fruit-dove within the study area.

The Rose-crowned Fruit-dove has the same habitat requirements for breeding as it does for foraging. Nesting could occur in forest lacking good foraging opportunities, but a source of food must be present nearby (DEC 2005). The proposed upgrade is unlikely to have a significant impact on the life-cycle of this species.

The small area of habitat to be cleared is of suboptimal quality and there are more extensive areas of potential habitat outside the study area.Given the poor quality of habitat to be cleared and that fragmentation is unlikely to increase, it is considered unlikely that a viable local population of the Rose-crowned Fruit-dove would be placed at risk of extinction by the proposed upgrade.

Sooty Owl *Tyto tenebricosa*

Description

The Sooty Owl is a dark sooty-grey medium sized owl, 40-45 centimetres in length. It has a prominent white, heart-shaped facial disk that is edged with black and silver. The eyes are large and black. The underparts are whitish (DECC, NPWS 2002).

The Sooty Owl is in a distinct subgenus, *Megastrix* (with the Lesser Sooty Owl and the Masked Owl), and is an Australasian endemic species (DEC 2006).

Conservation status

The Sooty Owl is listed as Vulnerable on Schedule 2 of the TSC Act.

The Sooty Owl is generally confined to the east of the Great Dividing Range, occurring on the coast, coastal escarpment and eastern tablelands. Within these limits is has known to have a patchy distribution. It is uncertain how well represented this species is in conservation reserves in NSW.

Habitat requirements

The Sooty Owl is often found in old-growth forests, including temperate and subtropical rainforests. In NSW this species is mostly found on escarpments with a mean altitude of greater than 500 m. The Sooty Owl nests and roosts in the

hollows of tall emergent trees (Higgins 1999), usually occupying the largest trees in a stand (Gibbons & Lindenmayer 2002). This species mainly occupies hollows of *Eucalyptus* spp. (Higgins 1999), and is often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 124 to 183 centimetres in diameter (Gibbons and Lindenmayer 2002).

The Sooty Owl hunts by night for small ground or tree-dwelling mammals such as Sugar Gliders or Common Ringtail Possums (NPWS 2002).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTPs 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and the 'Loss of Hollow Bearing Trees'. The KTP 'Human Caused Climate Change' may also have impacts on this species in the longer term (DEC 2006).

To date, no Threat Abatement Plan exists for the Sooty Owl (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

However, a Recovery Plan has been prepared for this species (DEC 2006b). DECC has listed 23 priority actions to help recover this species, some of which include:

- Apply low-intensity, mosaic pattern fuel reduction regimes;
- Searches for the species should be conducted in suitable habitat in proposed upgrade areas and proposed forest harvesting compartments;
- Retain at least a 200 m buffer of native vegetation around known nesting sites;
- Retain large stands of native vegetation, especially those containing hollow-bearing trees;
- Protect riparian vegetation to preserve roosting areas;
- Protect hollow-bearing trees for nest sites. Younger recruitment trees should also be retained to replace older trees in the long-term;
- Minimise visits to nests and other disturbances, including surveys using call playback, when owls are breeding; and,
- Assess the importance of the study area to the species' survival. Include the linkages the study area provides for the species between ecological resources across the broader landscape.

Local and regional abundance

The Sooty Owl has a patchy distribution on the coast, coastal escarpment and eastern tablelands on the east of the Great Dividing Range. One record of the species exists east of the study area near the coast.

Locations relative to limits of distribution

The study area is not on the limits of distribution of the Sooty Owl, which is widespread in north and east New Guinea and in east and south-east Australia. In NSW, this species is confined to the east coast where it has a patchy distribution (Higgins 1999).

Habitat (within study area)

Potential foraging habitat for the Sooty Owl exists in the study area in Lowland Rainforest. Patches of this plant community in the study area are generally considered to be of poor to medium quality, as they are small, highly fragmented and degraded.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest, potential foraging habitat for the species, would be removed with a further 3.6 ha affected indirectly. This represents less than 1% of moist forest and rainforest (including disturbed habitat) in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the already fragmented nature of the landscape, the lack of recent records of this species within the Locality and the species' high mobility, it is unlikely the proposed upgrade would fragment potential habitat for the Sooty Owl further. It is considered unlikely that that a viable local population of the Sooty Owl would be placed at risk of extinction by the proposed upgrade.

Spotted-tailed Quoll *Dasyurus maculatus*

Description

The Spotted-tailed Quoll is a medium-sized marsupial carnivore. It has rich-rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly, with a distinguishable long, spotted tail. It consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects. It also eats carrion and takes domestic fowl. Two subspecies are currently recognised *Dasyurus maculatus gracilis* in north Queensland, and *D. m. maculatus* in the southeast of the mainland and Tasmania. Research suggests that Tasmanian and mainland tiger quolls form two distinct evolutionary units and a revised classification and management plan are needed for the species (Firestone *et al.* 1999). The subspecies of consideration in this report is *Dasyurus maculatus maculatus*.

Conservation status

The Spotted-tailed Quoll is listed as Vulnerable on the TSC Act and Endangered on the EPBC Act.

The Spotted-tailed Quoll has been recorded from numerous conservation reserves throughout NSW and the local region, some including Cotton Bimbang National Park, Middle Brother National Park, Limburners Creek Nature Reserve, Bundjalong National Park, Yuraygir National Park, Gibraltar Range National Park, Broadwater National Park, Nightcap National Park, Fortis Creek, Border Ranges National Park and Bulga State Forest.

Potential habitat for this species exists in the study area in the Lowland Rainforest. This plant community is considered to be of low to moderate habitat quality due to its fragmented and degraded nature.

Habitat requirements

The Spotted-tailed Quoll uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Breeding habitat requirements include suitable den sites, including hollow logs, hollow-bearing trees, rock crevices, rock cliff-faces and caves, and abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTPs ‘Clearing of Native Vegetation’, ‘Removal of Dead Wood and Dead Trees’. This would involve the

removal of potential foraging and breeding habitat for this species.

Threats to the Spotted-tailed Quoll identified by the DECC include**:**

- Loss, fragmentation and degradation of habitat;
- Accidental poisoning during wild dog and fox control programs. Deliberate poisoning, shooting and trapping may also be an issue; and,
- Competition with introduced predators such as cats and foxes.

To date no Recovery Plan or Threat Abatement Plan has been prepared for this species. The DECC has identified 32 priority actions and lists recovery actions for the species. Those most applicable to the proposed upgrade include:

- Identify sections of roads where Spotted-tailed Quolls are frequently killed on roads. Conduct a media campaign to ask for public records of road kills and use data held by the relevant government agencies;
- At sections of roads where Spotted-tailed Quolls are frequently killed, incorporate methods to reduce the numbers of animals killed. Assess the effectiveness of different mitigation methods. Erect signs in areas where road kills are common to alert drivers to the presence of Spotted-tailed Quolls; and,
- Retain and protect large, forested areas with hollow logs and rocky outcrops, particularly areas with thick understorey or dense vegetation along drainage lines.

Local and regional abundance

The species is probably extinct in South Australia and uncommon to rare in Victoria, NSW and Queensland (Strahan 1995). Although no records exist within the study area, one 1981 record is located approximately 2 km south of the study area.There are nearly 3,000 records of the Spotted-tailed Quoll in NSW with nearly 800 records occurring within the Northern Rivers Region (DECC Atlas of NSW Wildlife, Bionet).

Locations relative to limits of distribution

The Spotted-tailed Quoll occurs on both sides of the Great Dividing Range, with a strong hold in the north east of NSW (NPWS 1999g). The Locality is towards the northern end of the species distribution with limited extension into south eastern Queensland.

Habitat (within study area)

Within the study area, potential foraging habitat exists within Lowland Rainforest. This plant community in the study area occurs as small, fragmented stands and are considered to be in moderate to poor condition. Rocky outcrops and caves are absent and fallen hollow logs and hollow-bearing trees are limited within the study area and therefore, it is unlikely that the area supports important breeding habitat for the species. Given the small area of potential habitat within the study area and the species large home range (750 – 3,500 ha), it is unlikely that the study area supports a population of the Spotted-tailed Quoll.

To date, critical habitat has not been declared for the Spotted-tailed Quoll, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Suitable foraging habitat occurs within and surrounding the study area.However, given the large home ranges found in this species (750 – 3,500 ha), it is unlikely that a population is dependent on the study area for its survival. It is also unlikely the study area contains important breeding sites for the Spotted-tailed Quoll as there are no rocky outcrops or caves present and hollow trees and logs are very limited. Therefore the proposed upgrade is unlikely to have a major impact on the breeding cycle of this species. The proposed upgrade would remove approximately 2.0 ha of potential habitat for the Spotted-tailed Quoll (Lowland Rainforest), which represents less than 1% of potential habitat in the Locality. Potential habitat for the Spotted-tailed Quoll in the study area was considered to be in moderate to poor condition due to its small, fragmented and degraded nature.

Given the already fragmented and disturbed nature of the landscape, it is unlikely the proposed upgrade would further fragment potential habitat for the Spotted-tailed Quoll. This species is highly mobile, enabling it to easily access habitat outside the development footprint. However, quolls are frequently killed on roads (DECC), which they may cross when the road fragments their habitat. The proposed upgrade interferes with one Subregional DEC wildlife corridor and one Subregional Byron Council wildlife corridor. However, as the road crosses part of these corridors underground, it is unlikely to further fragment habitat for this species.

Given the small area of habitat to be cleared, the suboptimal quality of the potential habitat within the study area, and that fragmentation would not increase, it is considered unlikely that a viable local population of the Spotted-tailed Quoll would be placed at risk of extinction by the proposed upgrade.

Square-tailed Kite *Lophoictinia isura*

Description

The Square-tailed Kite is a reddish, medium-sized, long-winged raptor. Adults have a white face with thick black streaks on the crown and finer streaks elsewhere. The saddle, rump and central upper tail coverts are blackish with grey-brown barring. The underparts are predominantly grey-brown with black tips on the grey, square-tipped tail and wing edges (DECC). It is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects, small mammals and reptiles from the tree canopy (Marchant and Higgins 1993b).

Conservation status

The Square-tailed Kite is listed as Vulnerable on the TSC Act.

Local Conservation Reserves the species has been recorded in include Billinudgel Nature Reserve; Bundjalung National Park; Yuraygir National Park; and Gilbraltar Range National Park.

It is not known if this species is adequately represented in conservation reserves.

Potential habitat for the species occurs within the study area in timbered watercourses and in adjacent agricultural grassland. These vegetation types include Lowland Rainforest. These plant communities in the study area are considered to be of low to moderate habitat quality due to their fragmented and degraded nature.

Habitat requirements

Square-tailed Kites are found in a variety of timbered habitats including dry woodlands and open forests, timbered watercourses, rocky hills and gorges (Marchant and Higgins 1993b). They show a particular preference for timbered watercourses. In arid NSW they are known to occur in open acacia scrub and tall eucalypts lining watercourses and nearby chenopod and grass plains. Individuals appear to occupy large hunting ranges of more than 100 km^2. They require large living trees for breeding, particularly near water, with adjacent woodland /forest for foraging. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993b).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP ‘Clearing of Native Vegetation’. This would involve the removal of limited potential foraging, roosting and nesting habitat for this species and its prey.

Several other activities have also been identified by the DECC or are considered

likely to lead to the long-term decline of this species including:

- Loss of habitat through clearing, logging, burning, and grazing of habitats resulting in a reduction in nesting and feeding resources;
- Illegal shooting and/or collection of eggs;
- Disturbance to nest;
- Disturbance to or removal of potential nest trees near watercourses
- Clearing of riparian vegetation;
- Unregulated timber harvesting along the main rivers: destroys nesting sites, and can impact on prey availability; and,
- Inappropriate fire and/or grazing regimes that may reduce nesting and foraging habitat.

The DECC has identified the following factors to assist the recovery of this species:

- Protect known habitat from fires of a frequency greater than that recommended for the retention of biodiversity;
- Retain and protect nesting and foraging habitat, particularly along watercourses; and,
- Report suspected illegal bird shooting and egg-collecting to DEC.

Local and regional abundance

The Square-tailed Kite is widespread but sparsely distributed throughout mainland Australia. It ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems.

There is one record of the species approximately 1.5 km west of the study area.The closest recordings of the species outside the Locality falls within the Byron LGA to the north and the Richmond Valley LGA to the south and south-west in Braemar State Forest.

Locations relative to limits of distribution

The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria.The Region is not at the limits of distribution for the species.

Habitat (within study area)

Potential habitat occurs within the study area in timbered waterways and in adjacent agricultural grassland. These habitats include Lowland Rainforest. These plant communities in the study area occur as small, fragmented and degraded patches and are considered to be in moderate to poor condition.

To date, critical habitat has not been declared for the Square-tailed Kite, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Potential habitat for the Square-tailed Kite exists across most of the study area.Although the proposed upgrade would remove 2.0 ha of Lowland Rainforest for the Square-tailed Kite and its prey species, this represents a very small proportion of habitat in the area (less than 1% of potential habitat in the Locality). The proposed upgrade would impact on less than 5% of grassland in the Locality. In addition, habitat in the study area is considered to be of poor to moderate quality due to its fragmentation and modification and thus is expected to provide limited habitat. There is to be limited impacts to tree-lined watercourses, so the proposed upgrade is unlikely to affect potential breeding habitat. Given the small size of the patches of vegetation to be impacted, these patches are already subject to edge effects and no new edge effects would be created by the proposed upgrade. This species is highly mobile, enabling it to easily access habitat outside the development footprint. For the reasons given above, it is considered unlikely that a viable local population of the Square-tailed Kite will be placed at risk of extinction by the proposed upgrade.

Superb Fruit-dove *Ptilinopus superbus*

Description

The Superb Fruit-dove is a small frugivorous rainforest pigeon. Part of the population is thought to be nomadic or migratory, though little is known of their movements (DEC 2005›) (Higgins and Davies 1996).

Conservation status

The Superb Fruit-dove is listed as Vulnerable on Schedule 2 of the TSC Act.

Due to the scattered and scarce records for this species, it is unknown whether it is adequately represented in conservation reserves within the region. It has been recorded nearby in Nightcap National Park (DECC Atlas of NSW Wildlife).

Within the study area, potential habitat for the species occurs in Lowland Rainforest and Camphor Laurel. In the local area, these plant communities largely occur as fragmented patches within a rural landscape.

Habitat requirements

The Superb Fruit-dove occurs in rainforest and similar closed forests where it forages on fleshy fruits from a variety of trees (including introduced species), vines and palms. It may also forage in eucalypt or acacia woodland where fruit-bearing trees are found (DEC 2005›). Its breeding habits are poorly known, but it has been recorded using horizontal forks of shrubs or small trees and vine thickets for nesting (Higgins and Davies 1996). It has been recorded nesting in wet schlerophyll forest or rainforest (including remnants dominated by camphor Laurel) near foraging habitat (DECC).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of feed trees, potential roosting and nesting habitat for this species.

To date, there is no Recovery Plan or Threat Abatement Plan for the Superb Fruit-dove (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

Local and Regional Abundance

Highest densities of the Superb Fruit-dove occur in north-eastern NSW, further south it is mainly confined to pockets of suitable habitat (DEC 2005›).

This species has not been recorded in the study area, but has been recorded twice in the Locality.

Locations relative to limits of distribution

The Superb Fruit-dove has a patchy coastal distribution ranging from Moruya in NSW to Cape York Peninsula (DECC Atlas of NSW Wildlife, Bionet). The study area is not at the limits of distribution of the Superb Fruit-dove.

Habitat (within study area)

Habitat within the study area is within Lowland Rainforest and Camphor Laurel. The species has not been recorded within the study area, but has been recorded nearby. Habitat for the species in the study area occurs as small, fragmented and degraded patches. These patches of vegetation are considered to be in moderate to poor condition, caused by their small, fragmented nature and modified structure and

species composition, due to impacts from the current road, agriculture and previous land clearing.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging, roosting and breeding habitat for the Superb Fruit-dove. Potential habitat within the study area is considered to be of moderate to poor quality and better quality habitat for this species exists elsewhere in the Locality (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 7.7 ha of Lowland Rainforest and Camphor Laurel (potential habitat) would be removed by the proposed upgrade. This represents less than 1% of potential habitat that occurs within the Locality. Vegetation mapping within the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for this species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, indirect impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Superb Fruit-dove within the study area.

The area of habitat that would be cleared is small, and there is a large amount of potential habitat within the Locality. Given that fragmentation is unlikely to increase, it is considered unlikely that a viable local population of the Superb Fruit-dove would be placed at risk of extinction by the proposed upgrade.

Three-toed Snake-tooth Skink *Coeranoscincus reticulatus*

Description

The Three-toed Snake-tooth Skink is a large, burrowing skink, growing to a body length of 23 cm plus a long, thick tail. True to its name, it has three toes on each

foot and curved, snake-like teeth.

Conservation status

The Three-toed Snake-tooth Skink is listed as Vulnerable on both the TSC and EPBC Acts.

This species has been recorded in Night Cap National Park and Mebbin Nature Reserve to the north-west of the study area.It has also been recorded in several conservation reserves to the west in the Great Dividing Range. It has not been recorded in any conservation reserves within the Locality. It is rarely recorded due to its burrowing habits. It is unknown whether it is adequately represented in conservation reserves.

Potential habitat for this species exists in the study area in Lowland Rainforest vegetation type. This plant community is considered to be of low to moderate habitat quality due to its fragmented and degraded nature.

Habitat requirements

The Three-toed Snake-tooth Skink is a burrowing skink usually found in rotting logs or in the soil under logs (Swan 1990). Little is known about this species, but it is generally an inhabitant of rainforests and wet sclerophyll forests (Cogger 1992). It feeds on earthworms, coleopteran larvae, and insects (Swan 1990).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the following Key Threatening Processes as listed in the TSC Act:

- ‘Clearing of native vegetation’; and,
- ‘Removal of dead wood and dead trees’.

No Threat Abatement Plan has been prepared for this species to date. The DECC has compiled a list of priority actions to aid in the recovery of the species. Those actions relevant to the proposed upgrade are listed below:

- Prevent clearing of woodland and forest habitats where the species is known to occur; and,
- Do not stock-pile or burn logging waste in forest or woodland where the species occurs.

Local and regional abundance

The species is poorly known due to the low rate at which it is encountered. It has

not been recorded within the Locality or the study area.

In the NSW North Coast Bioregion, the species has a patchy and scattered distribution, with records typically being clustered in isolated pockets. It is most common west of the study area in the Great Dividing Range. Its distribution is small in Queensland as well as NSW.

Location relative to limits of distribution

This species ranges as far south as Grafton in NSW (Wilson and Swan 2003). The study area is not considered to be at the limits of the species' known distribution.

Habitat (in study area)

Potential habitat for this species exists in the study area within Lowland Rainforest. Potential habitat available for this species in the study area is mostly considered to be of poor to moderate quality due to the small, fragmented and degraded nature of the patches.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest, potential habitat for the species, would be removed with a further 3.6 ha affected indirectly. This represents less than 1% of moist forest and rainforest (including disturbed habitat) in the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Little is known about the breeding biology of the Three-toed Snake-tooth Skink. The species is recorded as having a clutch size of 2-6 eggs (Wilson and Swan 2003). Due to the small area of potential habitat to be cleared, it is unlikely the proposed upgrade would impact on the life-cycle of this species.

Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would further fragment potential habitat for the Three-toed Snake-tooth Skink. To date, critical habitat has not been declared for this species, therefore the proposed upgrade is not likely to interfere with critical habitat.

Due to the small area of potential habitat to be cleared and that fragmentation would not increase, it is unlikely that a viable local population of the Three-toed

Snake-tooth Skink would be placed at risk of extinction by the proposed upgrade.

White-eared Monarch *Monarcha leucotis*

Description

The White-eared Monarch is a medium-small, pied monarch flycatcher. They have a characteristic hovering flight when foraging, and a distinctive, two-note call. They feed on insects, generally in the upper canopy, pursuing them in the manner of a flycatcher (Slater *et al.* 2003).

Conservation status

The White-eared Monarch is listed as Vulnerable under the TSC Act.

This species has been recorded in Victoria Park Nature Reserve, Night Cap National Park, Goonengerry National Park and Mount Jerusalem National Park. To the south of the region, the species has been recorded in Bundjalung National Park and Broadwater National Park. This species is probably moderately well represented in conservation reserves in the region, but its representation in conservation reserves throughout its entire range is unknown.

Habitat for this species exists in the study area within Lowland Rainforest, with some potential for sheltering and foraging in Camphor Laurel. The patches of these vegetation types in the study area are considered to be of low to moderate quality as they are small and highly fragmented.

Habitat requirements

The White-eared Monarch is usually found in coastal or near-coastal rainforests, typically in the drier associations of these vegetation types (Higgins *et al.* 2006). They also occur sometimes in mangroves, paperbark swamps (Slater *et al.* 2003), dense ecotones, and along forest and creek edges (Higgins *et al.* 2006). They spend most of their time high in the canopy foraging for insects. This species is considered to be resident at sites in Southern Queensland and northern NSW, but some seasonal movement may occur (Higgins *et al.* 2006).

Key Threatening Processes, Recovery and Threat Abatement Plans

This species is threatened by the Key Threatening Process as listed in the TSC Act: ‘Clearing of native vegetation’. This would involve the removal of nesting and foraging recourses for the species.

No Threat Abatement Plan has been prepared for White-eared Monarch to date. The DECC has developed a list of priority actions to help in the recovery of this

species. Those actions relevant to the proposed upgrade are listed below:

- Ensure protection of rainforest and that wet and swamp sclerophyll forest is included in fire planning and hazard reduction guidelines;
- Prevent lowland rainforest and wet and swamp sclerophyll forest habitat loss and fragmentation. Expand and reconnect habitat;
- Address threats including loss of habitat, fragmentation and degradation; and,
- Ensure that Camphor Laurel removal is compensated for by replacement with rainforest species.

Local and regional abundance

The White-eared Monarch has been recorded 10 times within the Locality, all between the study area and the coast.

In the wider region, the species is widespread in the north of the state, especially within large conservation reserves in the Great Dividing Range. Records south of the study area are scattered and sparse. The species is probably uncommon in the Locality, moderately common in the north of the region and rare in the south of the region.

Location relative to limits of distribution

The species has a northerly distribution up the eastern coast to Cape York. In NSW, the species is generally confined to the northern rivers. The most southerly records of the species come from Iluka, or occasionally Woolgoolga (Higgins *et al.* 2006). In recent years, there have been some records from Crowdy Bay National Park, near Taree. The study area is not considered to be at or close to the limits of distribution for this species.

Habitat (in study area)

Potential habitat for this species exists in the study area in Lowland Rainforest, with limited potential for shelter and forage habitat in Camphor Laurel dominated vegetation. Most of the portions of these vegetation types in the study area are of poor to moderate quality due to their fragmented and disturbed nature.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

Approximately 2.0 ha of Lowland Rainforest and 5.7 ha of Camphor Laurel habitat for the species would be removed. This represents less than 1% of potential habitat

that occurs within the Locality.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

The breeding biology of the White-eared Monarch is not well known, but it is believed that breeding habitat is no different to foraging habitat (Higgins *et al.* 2006). Nests are rarely seen as they are usually high in the canopy (Slater *et al.* 2003). It is suggested that the species, while usually quite bold, will abandon a nest in the construction phase at the slightest disturbance (Higgins *et al.* 2006). Due to the small proportion of poor quality habitat to be cleared, it is unlikely the proposed upgrade would have a significant impact on the life-cycle of this species.

Approximately 2.0 ha of potential habitat would be directly and indirectly impacted by the proposed upgrade. Given the already fragmented nature of the landscape, it is unlikely the proposed upgrade would fragment potential habitat for the White-eared Monarch further. The distribution of records for this species suggests that it prefers large tracts of relatively undisturbed forests. As such, it is unlikely the study area contains preferred habitat for this species, and it is unlikely that a viable local population of the species would be placed at risk of extinction by the proposed upgrade.

Wompoo Fruit-dove *Ptilinopus magnificus*

Description

The Wompoo Fruit-dove is a large frugivorous rainforest pigeon. Three geographically distinct subspecies are recognised, the most southerly being *Ptilinopus magnificus magnificus*, which occurs from NSW to south-eastern Queensland (DEC 2005¦).

Conservation status

The Wompoo Fruit-dove is listed as Vulnerable on Schedule 2 of the TSC Act.

This species has been recorded in the following nature reserves in the region Victoria Park Nature Reserve, Boatharbour Nature Reserve and Tucki Tucki Nature Reserve. Additionally, there is a population of the Wompoo Fruit-dove in Nightcap National Park (DECC Atlas of NSW Wildlife). Therefore, it is likely that this species is adequately represented in conservation reserves within the region.

Within the study area, potential habitat for the species occurs in Lowland Rainforest. In the local area, this plant community largely occurs as fragmented patches within a rural landscape. The Wompoo Fruit-dove has been recorded to eat the fruit of Camphor Laurel (Higgins and Davies 1996), thus it may also utilise plant communities dominated by this introduced species in the study area .

Habitat requirements

The Wompoo Fruit-dove occurs in mainly in large patches of tall tropical or subtropical rainforest. It breeds in the mid-strata of dense rainforest and forages in the dense canopy of large rainforest trees. The Wompoo pigeon is an obligate frugivore, obtaining fleshy fruit from a wide range or rainforest trees, palms, vines and epiphytes for foraging (Higgins and Davies 1996) (Innis 1989b).

Key Threatening Processes, Recovery and Threat Abatement Plans

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed upgrade would involve the operation of the KTP 'Clearing of Native Vegetation'. This would involve the removal of feed trees, potential roosting and nesting habitat for this species.

To date, there is no Recovery Plan or Threat Abatement Plan for the Wompoo Fruit-dove (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Recovery+plans).

Local and regional abundance

This species has not been recorded in the study area, but has been recorded on multiple (>10) occasions within the Locality. On a state level, it is confined to the coast, extending about 150 km inland. NSW records are concentrated to the north of the state, with the southernmost records appearing just north of Sydney (NPWS, Bionet).

Locations relative to limits of distribution

The study area is far from the limits of distribution of the Wompoo Fruit-dove, which has a coastal distribution, ranging from the Hunter River in NSW to Cape York Peninsula.

Habitat (within study area)

Habitat within the study area is within Lowland Rainforest (EEC). There is also some potential for this species to utilise Camphor Laurel plant communities for foraging. Habitat for the species in the study area occurs as small, fragmented stands. These patches of vegetation were considered to be in moderate to poor condition, due to their small, fragmented nature, and modified structure and species

composition. The patches of vegetation within the study area are considered to be in moderate to poor condition, due to impacts from the current road, agriculture and clearing, which have highly fragmented the vegetation.

To date, critical habitat has not been declared for this species (DEC 2004c), and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Likely impacts on long-term viability and rate of extinction of threatened species, populations and ecological communities

The proposed upgrade would entail clearing of potential foraging, roosting and breeding habitat for the Wompoo Fruit-dove. Potential habitat within the study area is considered to be of moderate to poor quality and better quality habitat for this species exists elsewhere in the Locality (for example, larger continuous patches of habitat within nearby nature reserves).

Approximately 2.0 ha of Lowland Rainforest and an additional 5.7 ha of Camphor Laurel would be removed by the proposed upgrade. This represents less than 1% of potential habitat which occurs in the Locality. Vegetation mapping of the Locality includes broad vegetation classes and therefore these figures are an approximation only.

Indirect impacts to the potential habitat for the species includes an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Given the highly modified nature, small size and existing fragmentation of the patches of potential habitat that would be impacted by the proposed upgrade, indirect impacts on potential habitat are unlikely to significantly reduce the quality of potential habitat for the Wompoo Fruit-dove within the study area.

Given the area of habitat that would be cleared is small, there is a large amount of better quality habitat outside the study area, the species is highly mobile and that fragmentation would not increase, it is considered unlikely that a viable local population of the Wompoo Fruit-dove would be placed at risk of extinction by the proposed upgrade.

Appendix 8
EPBC Act Significant Impact Criteria Assessments

Endangered Species

Flora

Ten plant species listed as Endangered on the EPBC Act are considered to have potential habitat in the study area : *Davidsonia jerseyana, Davidsonia johnsonii, Diploglottis campbellii, Elaeocarpus williamsianus, Endiandra floydii, Gossia fragrantissima, Isoglossa eranthemoides, Ochrosia moorei, Phaius australis* and *Randia moorei.* These plant species are assessed against the Significant Impact Criteria for Endangered species below:

Davidsonia jerseyana

Davidsonia jerseyana is a small tree that grows to 10 m tall, either with a single unbranched stem or several stems arising from the base and large, hairy leaves that are bunched towards the top of the trunk (DEC 2005l). The flowers are small and pinkish flowers and are borne directly from the main stem in long, loose clusters (DEC 2005l).

Potential habitat for *Davidsonia jerseyana* exists in Lowland Subtropical Rainforest and Wet Eucalypt Forest at low altitudes (below 300m) (DEC 2005l).

This species has not been recorded in the study area, but has previously been recorded to the east of the study area, approximately 550 m east of the proposed upgrade in a plantation to the south of St Helena Road. There are also a number of records of the species to the north and east of the study area.Potential habitat for *Davidsonia jerseyana* exists in the Lowland Rainforest in the study area, with approximately 2.0 ha occurring within the Subject Site and a further 3.6 ha within 50 m of the proposed upgrade.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

No known records of *Davidsonia jerseyana* would be impacted by the proposed upgrade, with the closest known record occurring approximately 1 km to the east of the proposed upgrade, south of St Helena Road. The proposed upgrade is therefore not likely to lead to a long-term decrease in the size of a population of the species.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Davidsonia jerseyana* occurs in Lowland Rainforest in the study area.The removal of 2.0 ha of vegetation that is potential habitat for

Davidsonia jerseyana, with a further 3.6 ha indirectly impacted within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species given that no known individuals of the species would be impacted and that there is approximately 776 ha of potential habitat mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Davidsonia jerseyana* would be impacted by the proposed upgrade, with the closest record occurring approximately 1 km to the east. Potential habitat for *Davidsonia jerseyana* that would be directly impacted as part of the proposed upgrade consists of approximately six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Davidsonia jerseyana* or any potential habitat for the species.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Davidsonia jerseyana* has been listed on the Register of Critical Habitat. A Recovery Plan has been prepared for *Davidsonia jerseyana*, but does not list any critical habitat for the species.

The potential habitat for *Davidsonia jerseyana* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site. On this basis the impacted area is not likely to be necessary

for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

The following is known about the breeding cycle of *Davidsonia jerseyana* (DEC 2004c):

- Frequently occurs in clumps with a number of stems separated at ground level, which assumed to be due to a combination of root suckering plus seedlings developing from seeds dropped below the parent.
- Trees in cultivation have been recorded as producing viable fruit after five years.
- Known to bear flowers and fruits when very small, especially when stressed.
- Little information is available on the pollination of *Davidsonia jerseyana*. The size and form of the flower suggest that vectors are likely to be small insects. Ants (species uncertain) were the only visitors to the flowers during diurnal and nocturnal observation of the flowers; however they are unlikely to act as pollinators for this species.
- Fruiting times apparently vary between subpopulations. The age at which individual plants reach their peak fruiting is unknown.
- Little is known of seed dispersal in *Davidsonia jerseyana*, flying foxes have been observed eating unripe Davidson's Plum fruit, while distinct bird bill imprints and rodent teeth marks on ripe fruit have also been observed. King Parrots have been observed eating the seeds.
- Easily grown from seed, and is readily established. The seeds have a very high viability rate, at around 80%. There is no dormancy period in *Davidsonia jerseyana* seeds and there is no evidence of soil storage of seeds.

Davidsonia jerseyana was not recorded within the study area.The proposed upgrade is not likely to disrupt the breeding cycle of a population as no known records of the species would be impacted.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Davidsonia jerseyana*, with a further 3.6 ha indirectly impacted within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area, from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Davidsonia jerseyana* that would be directly impacted as part of the proposed works consists of approximately six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed upgrade is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Davidsonia jerseyana* are generally in poor condition, due to weed invasion and lack of vegetation structure. The species is known to occur in patches of vegetation that are infested with Camphor Laurel and Lantana and these exotic species threaten the recruitment of seedlings of *Davidsonia jerseyana.* Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion and should be described in a Vegetation Management Plan.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 2.0 ha of potential habitat for *Davidsonia jerseyana*, and indirect impacts to an additional 3.6 ha within 50 m of the proposed upgrade, is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native

vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan has been prepared for *Davidsonia jerseyana* (DEC 2004c), and lists six objectives to assist in the recovery of the species. Of these, one is considered relevant to the proposed upgrade as follows:

- Manage and protect *Davidsonia jerseyana* and associated habitat from threatening processes – the proposed upgrade would result in direct and indirect impacts to potential habitat of the species.

The Recovery Plan lists the following threats to *Davidsonia jerseyana* (DEC 2004c):

- Habitat alteration and fragmentation
- Loss of genetic variation
- Genetic pollution
- Collection for the bush food and nursery industry.

Roads, and specifically pacific highway upgrades, are listed in the Recovery Plan as a mechanism that could increase the threat of habitat fragmentation for *Davidsonia jerseyana*. The proposed upgrade would not increase fragmentation of habitat of *Davidsonia jerseyana*, as potential habitat for *Davidsonia jerseyana* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species.

Conclusion

Based on the above assessment, *Davidsonia jerseyana* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Davidsonia johnsonii

Davidsonia johnsonii is a bushy, well-branched tree, 5 – 12 m tall, with a dense crown (DEC 2005•). The smooth, glossy leaves are large and divided into 7 - 9 toothed leaflets (DEC 2005•). Small, pinkish flowers are borne in loose clusters

(DEC 2005•).

Potential habitat for *Davidsonia johnsonii* exists in disturbed subtropical rainforest or on the margins of wet sclerophyll forest and gully rainforest at low altitudes (below 300 m) (DEC 2005•).

This species has not been recorded within the Subject Site, but has previously been recorded in the study area, with one recording approximately 350 m to the south of the proposed upgrade, south of Sandy Flat Road. An additional six records exist to the east of the study area in Broken Head Nature Reserve and one record to the west of Broken Head Nature Reserve along a creekline. Potential habitat for *Davidsonia johnsonii* exists in the Lowland Rainforest in the study area, with approximately 2.0 ha within the proposed upgrade and an additional 3.6 ha within 50 m of the proposed upgrade.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

No known records of *Davidsonia johnsonii* would be impacted by the proposed upgrade, with the closest known record occurring approximately 350 m to the south of the proposed upgrade, south of Sandy Flat Road. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Davidsonia johnsonii* occurs in Lowland Rainforest in the study area.The removal of 2.0 ha of vegetation that is potential habitat for *Davidsonia johnsonii*, with an additional 3.6 ha of potential habitat indirectly impacted within 50 m of the proposed upgrade, is not likely to reduce the area of occupancy of the species, given that no known individuals would be impacted and that there is approximately 776 ha mapped as occurring in the Locality (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Davidsonia johnsonii* would be impacted by the proposed upgrade, with the closest record occurring approximately 450 m to the south-east of the Subject Site. Potential habitat for *Davidsonia johnsonii* that would be directly impacted as part of the proposed upgrade consists of approximately six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Davidsonia johnsonii* or any potential habitat for the species.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Davidsonia johnsonii* has been listed on the Register of Critical Habitat. A draft Recovery Plan has been prepared for Davidsonia johnsonii, but does not list any critical habitat for the species.

The potential habitat for *Davidsonia johnsonii* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and so the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

The following is known about the breeding cycle of *Davidsonia johnsonii* (DEC 2004f):

- Reproduces vegetatively by way of root suckers. Suckers are particularly prolific where soil has been disturbed or plants slashed. This mode of reproduction has enabled patches of the species to survive even when surrounding vegetation has been completely cleared. Some patches appear to have regrown following the abandonment of pasture or banana plantations.
- Flowering at some sites has been detected as early as September, but at other sites, flowering did not commence until November.

- Mode of pollination of *Davidsonia johnsonii* flowers is not understood. The size and form of the flower suggest that the vectors are likely to be small insects. Bees (including native bees), beetles and ants have been observed visiting the flowers.

- Fruiting occurs between December and March, but occasional fruit occurs as late as June.

- There have only been two instances of seed being found within the fruit of this species. Reasons for the low incidence of seed production may include isolation from compatible plants, lack of production of pollen, no transfer of pollen from anther to stigma, nonviable pollen, self-incompatibility mechanisms, and early abortion of the developing embryo.

- Limited observation of ex-situ individuals suggests that the species is moderately slow growing and that first fruiting by individuals occurs approximately ten years after propagation, at a height of 2–3 m. The age at which the production of root suckers can commence, and the extent to which soil disturbance and/or physical root damage is necessary, is unknown.

Davidsonia johnsonii was not recorded within the Subject Site. The proposed upgrade is unlikely to disrupt the breeding cycle of a population as no known records of the species would be impacted.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Davidsonia johnsonii*, with a further 3.6 ha of potential habitat indirectly impacted within 50 m of the proposed upgrade. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Davidsonia johnsonii* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in

a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed upgrade is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

Many known records of *Davidsonia johnsonii* are from areas of regrowth vegetation, or on the edges of forests, situations in which it is particularly prone to exotic weed competition (DEC 2004f). At a number of locations on private land, Lantana and/or native vines are overtopping the species, competing for light and resources and physically weighing down the plants (DEC 2004f). Both sites recorded from conservation reserves occur on a forest edge and are threatened by exotic weed competition (DEC 2004f).

The patches of vegetation within the Subject Site that are potential habitat for *Davidsonia johnsonii* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edge effects will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 2.0 ha of potential habitat for Davidsonia johnsonii, with a further 3.6 ha of potential habitat within 50 m of the proposed upgrade, is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Draft Recovery Plan has been prepared for *Davidsonia johnsonii* (DEC 2004f), and lists six objectives to assist in the recovery of the species. Those relevant to the proposed upgrade include:

- To manage and protect the *Davidsonia johnsonii* population and associated habitat – the proposed upgrade would result in impacts to potential habitat for the species.

The Recovery Plan lists the following threats to *Davidsonia johnsonii* (DEC

2004f):

- Habitat destruction and fragmentation - the proposed upgrade would result in the removal of approximately 2.0 ha of native vegetation that is potential habitat for *Davidsonia johnsonii*. The proposed upgrade would not result in the fragmentation of any areas of habitat, as the patches of vegetation impacted exist as small isolated patches in a predominantly cleared landscape, with only the edges of each patch impacted.

- Habitat degradation, including weed infestation - the patches of potential habitat impacted the proposed upgrade were considered to be in poor condition due to existing weed infestation. The proposed upgrade may, however, result in the increase in weed infestation in the impacted patches. A number of recommendations have been made to reduce the threat of increase weed invasion, such as bush regeneration and using locally native species in landscaping.

- Lack of genetic variation - the proposed upgrade would not further reduce the genetic variation of *Davidsonia johnsonii,* as no known populations would be impacted by the proposed upgrade.

- Road construction and maintenance - the proposed upgrade does not impact on any known populations of *Davidsonia johnsonii*, but will impact directly on approximately 5.6 ha of potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known records of the species would be impacted.

Conclusion

Based on the above assessment, *Davidsonia johnsonii* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Diploglottis campbellii

Diploglottis campbellii is a large tree to 30 m tall (DEC 2005”). Small clusters of greenish-white flowers are borne amongst the leaves and the fruits are creamy-brown and in crowded clusters about 10 cm long (DEC 2005”).

The forest types in which *Diploglottis campbellii* occurs vary from lowland subtropical rainforest to drier subtropical rainforest with a Brush Box open overstorey on basalt-derived soils and also on poorer soils such as those derived

from quartz monzonite (DEC 2005").

Diploglottis campbellii has been recorded within the study area (Figure 3), with:

- Two records in a patch of replanted Lowland Rainforest (Patch 10, Figure 2), to the immediate west of the Pacific Highway at Newrybar (Yarrenbool Place). Collectively, these records represent two planted individuals in the directly impacted area; and,
- One record immediately south-east of Patch 12 (Figure 2). This record represents one individual and is within the indirectly impacted area.

There are also an additional 26 records of *Diploglottis campbellii* within a 10 km radius of the study area.

In additional to the above mentioned known habitat, potential habitat for *Diploglottis campbellii* occurs in the study area in Lowland Rainforest and patches of Camphor Laurel. The proposed upgrade would impact:

- Approximately 2.0 ha of Lowland Rainforest directly impacted and approximately 3.6 ha indirectly impacted; and,

- Approximately 5.7 ha of Camphor Laurel would be directly impacted and 9.5 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

There are 25 sites at which *Diploglottis campbellii* is known to occur, with the total known population estimated at 106 mature trees plus immature trees, saplings and seedlings (DEC 2004a). In addition to these naturally occurring sub-populations, a large number of individuals have been propagated and planted in ex-situ locations, with 6,000 trees distributed since 1993 (DEC 2004a).

Diploglottis campbellii was recorded within the Subject Site during the current survey, with two known records being directly impacted by the proposed upgrade (both of which are planted) and one known record being indirectly impacted.

Indirect impacts to *Diploglottis campbellii* as a result of the proposed upgrade are likely to be restricted to increased runoff, as the trees occur within small patches of Lowland Rainforest which are already impacted by edge effects. Impacts of increase runoff will be minimised through mitigation measures including the implementation of best practice sediment and erosion controls.

Given that the directly impacted individuals are planted and the plant within the area of indirect impacts will be protected from indirect impacts through mitigation, the proposed upgrade is not likely to lead to a long term decrease in the size of a

population.

Is the action likely to reduce the area of occupancy of the species?

Two areas of known habitat for *Diploglottis campbellii* would be impacted by the proposed upgrade. Potential habitat for *Diploglottis campbellii* occurs in Lowland Rainforest and Camphor Laurel Forest in the study area, with 7.7 ha being directly impacted and an additional 20.8 ha being indirectly impacted. The study area is near the southern limit of distribution of the species, with known records extending as far south as Cumbalum.

The removal of 7.7 ha of vegetation that is habitat for *Diploglottis campbellii* is not likely to reduce the area of occupancy for the species, given that the two known records that would be directly impacted are planted and the indirectly impacted plant will be protected from impacts through mitigation measures.

Is the action likely to fragment an existing population into two or more populations?

Two known records of *Diploglottis campbellii* would be directly impacted by the proposed upgrade, with an additional record being indirectly impacted. Known records of *Diploglottis campbellii* occur to the east and west of the existing Pacific Highway and are located within small fragmented patches of vegetation. The proposed upgrade generally follows the existing Pacific Highway in the vicinity of the known records that would be impacted. Therefore, the proposed upgrade would not result in the further fragmentation of any populations of *Diploglottis campbellii*.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological

community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Diploglottis campbellii* has been listed on the Register of Critical Habitat. A Recovery Plan has been prepared for *Diploglottis campbellii* (DEC 2004a), but does not identify any areas of critical habitat for the species.

The known habitat for *Diploglottis campbellii* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the impacted areas consist of two small fragmented patches, one of which is a stand of planted rainforest trees within a landscaped garden area. Given the small size of these patches and their highly modified nature, they are not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

The following is known about the breeding cycle of *Diploglottis campbellii* (DEC 2004a):

- Flowering time is from November to March. The method of pollination is unknown.
- Ripe fruit are generally present from January to early April.
- Seed dispersal mechanisms are not fully understood, yet flooding and down-slope dispersal may play a role in dispersal of seed. Fruit type is suitable for avian dispersal, but ripe fruit has been observed under trees showing no signs of being chewed.
- Viability testing showed that seed viability varies from 43% to 100%; however actual germination rates have been shown to be lower than this.
- The species occurs as isolated sites throughout most of its range, each site consisting of less than 20 adults, with only nine sites actively recruiting seedlings and juveniles.

Two individuals of *Diploglottis campbellii*, both of which are planted, would be impacted by the proposed upgrade. Indirect impacts are likely to be restricted to increased runoff, which will be minimised through mitigation measures. These indirect impacts on one known record, in addition to the removal of two known planted records of the species and removal of approximately of 7.7 ha of potential habitat is not likely to disrupt the breeding cycle of a population.

Is the action likely to modify, destroy, remove or isolate or decrease the

availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 7.7 ha of known and potential habitat for *Diploglottis campbellii.* The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar native vegetation that exists in the Locality (based on 776 ha of Rainforest in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted and the fact that only two planted individuals will be directly impacted, the removal of approximately 7.7 ha of habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Diploglottis campbellii* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation and 16 patches of Camphor Laurel in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed upgrade is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are known and potential habitat for *Diploglottis campbellii* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edge effects would be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 7.7 ha of habitat for *Diploglottis campbellii* is not

likely to introduce disease that may cause the species to decline. However, as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan for *Diploglottis campbellii* has been prepared (DEC 2004a). The Recovery Plan lists seven recovery objectives and a number of actions required to reach these objectives. One of these is relevant to the proposed upgrade as follows:

- To manage and protect the *Diploglottis campbellii* population and associated habitat – habitat for the species would be impacted by the proposed upgrade.

The Recovery Plan makes specific mention of the threat of road development, with one of the actions of the Recovery Plan being (DEC 2004a):

> 'Road development and widening activities and roadside maintenance in areas identified as having *Diploglottis campbellii* present will be restricted to actions that avoid damage to the species or its habitat'.

The development of the preferred route for the proposed upgrade has taken into consideration the presence of threatened species and has attempted to avoid known records and areas of habitat. However, the proposed upgrade would result in the removal of two (planted) known records Diploglottis campbellii, and indirectly impact a third known record. Additionally, approximately 7.7 ha of habitat would be impacted. The implementation of mitigation measures will reduce indirect impacts.

The proposed upgrade is not likely to interfere with the recovery of *Diploglottis campbellii*, as the proposed upgrade results in the removal of two known records, both of which are planted. There is an additional record of the species which occurs within the indirect impact area. This plant should be protected during construction works.

Conclusion

Provided the individual *Diploglottis campbellii* within the indirectly impacted area is adequately protected during construction activities, only two planted individuals of the species would be directly impacted. On this basis, the proposed upgrade is not likely to result in a significant impact to the species and, as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Elaeocarpus williamsianus

Elaeocarpus williamsianus is a small tree up to 15 m tall, with creamy brown bark.

The leaves measure 9 – 18 cm long and 2 – 5 cm wide, and are glossy green above and covered in rusty hairs below. The leaves have rounded tips, and may have a few shallow teeth and a joint where the leaf-blade meets the leaf-stalk. Small clusters of greenish-white flowers are borne amongst the leaves. The fruits are blue, shiny and round, and about 2 – 3 cm in diameter (DEC 2005|).

Elaeocarpus williamsianus occurs along the coastal range within notophyll vine rainforests and wet sclerophyll ecotones on metasediment-derived soils (DEC 2004g). The species is also known to occur in subtropical to warm temperate rainforest, including regrowth areas where it has apparently regrown from root suckers after clearing (DEC 2005|). The species is typically found on steep and eroding slopes at low altitude in gullies, toe slopes and steep drops adjacent to creeks and the headwater areas of creeks (DEC 2004g).

This species has not been recorded in the study area, however, it has been previously recorded within a 10 km radius of the study area, with two recordings to the east. Potential habitat for this species exists in Lowland rainforest and Camphor Laurel forest in the study area, with approximately 7.7 ha being removed or modified and an additional 20.8 ha within 50 m of the proposed upgrade.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Elaeocarpus williamsianus was not recorded within the Subject Site during the current survey. No known records of *Elaeocarpus williamsianus* would be impacted by the proposed upgrade, with the closest known records occurring over 4 km to the east of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Elaeocarpus williamsianus* occurs in Lowland Rainforest and Camphor Laurel Forest in the study area.The removal of 7.7 ha of vegetation that is potential habitat for *Elaeocarpus williamsianus* is not likely to reduce the area of occupancy for the species, given that there are no known records of the species in the area that would be impacted and that there is approximately 776 ha mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Elaeocarpus williamsianus* would be impacted by the proposed upgrade, with the closest known record of the species occurring approximately 4 km to the east of the study area.Potential habitat for *Elaeocarpus williamsianus* that would be directly impacted as part of the proposed upgrade

consists of six small, isolated patches of Lowland Rainforest and 16 patches of Camphor Laurel in a predominantly cleared landscape. The proposed upgrade would not result in the fragmentation of any populations of *Elaeocarpus williamsianus*.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Elaeocarpus williamsianus* has been listed on the Register of Critical Habitat. A draft Recovery Plan has been prepared for *Elaeocarpus williamsianus* (DEC 2004h), but does not identify any areas of critical habitat for the species.

The potential habitat for *Elaeocarpus williamsianus* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

Elaeocarpus williamsianus was not recorded within the Subject Site. The proposed upgrade is not likely to disrupt the breeding cycle of a population as no known populations of the species would be impacted.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to

decline?

The proposed upgrade would result in the removal of approximately 7.7 ha of potential habitat for Elaeocarpus williamsianus. The area to be directly impacted represents 0.3% of rainforest habitat in the local area (based on 776 ha from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that there are no known records of the species within the study area, the removal of 7.7 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Elaeocarpus williamsianus* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation and 16 patches of Camphor Laurel in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed upgrade is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Elaeocarpus williamsianus* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edge effects will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 7.7 ha of potential habitat for *Elaeocarpus williamsianus* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan has been prepared for *Elaeocarpus williamsianus* (DEC 2004g). A number of recovery objectives have been identified in the Recovery Plan (DEC 2004g). None of the listed objectives are relevant to the proposed upgrade as the species was not recorded in the study area .

DECC have listed a number of recovery actions to assist in the recovery of the species. Those relevant to the proposed upgrade include (DEC 2005|):

- Avoid fire around the edges of rainforest patches – the proposed upgrade is not likely to alter the fire frequency within the local area.
- Identify populations along roadsides and protect them during road-works – the species was not recorded in the study area.
- Control introduced weeds in rainforest areas – weed control works should be detailed in a Vegetation Management Plan.
- Protect areas of rainforest habitat from clearing and fragmentation – potential habitat for *Elaeocarpus williamsianus* will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of the species, as known habitat for the species will not be impacted.

Conclusion

Based on the above assessment, *Elaeocarpus williamsianus* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Endiandra floydii

Endiandra floydii is a small tree to 15 m tall, often with coppice shoots at the base, and with dark green shiny adult leaves, and pinkish-brown new leaves (DEC 2005k). The small green to cream flowers are held in small clusters back within the leaves and the fruits are red to purplish-black when ripe (DEC 2005k).

Endiandra floydii occurs in warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest (DEC 2005k).

This species has not been recorded in the study area ; however, it has been previously recorded within a 10 km radius of the study area, with two recordings to the east. Potential habitat for this species exists in Lowland Rainforest and

Camphor Laurel forest in the study area, with approximately 7.7 ha being removed or modified and an additional 20.8 ha indirectly impacted within 50 m of the proposed upgrade.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Endiandra floydii was not recorded within the Subject Site during the current survey. No known records of *Endiandra floydii* would be impacted by the proposed upgrade, with the closest known records occurring approximately 5 km to the east of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Endiandra floydii* occurs in Lowland Rainforest and Camphor Laurel Forest in the study area.The removal of 7.7 ha of vegetation that is potential habitat for *Endiandra floydii* is not likely to reduce the area of occupancy for the species, given that there are no known records of the species in the area that would be impacted and that there is approximately 776 ha of potential habitat mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Endiandra floydii* would be impacted by the proposed upgrade, with the closest known record of *Endiandra floydii* occurring approximately 5 km to the east of the study area.Potential habitat for *Endiandra floydii* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of Lowland Rainforest and 16 patches of Camphor Laurel in a predominantly cleared landscape. The proposed upgrade would not result in the fragmentation of any populations of *Endiandra floydii*.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);

- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Endiandra floydii* has been listed on the Register of Critical Habitat. A draft Recovery Plan has been prepared for *Endiandra floydii* (DEC 2004h), but does not identify any areas of critical habitat for the species.

The potential habitat for *Endiandra floydii* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

The following is known about the breeding cycle of *Endiandra floydii* (DEC 2004h):

- The flowering time is between April and May, but flowering has also been observed in January and February, August and November.
- No information about pollinating agents is available.
- Fruiting occurs from December to February, and in May. Fruit is not produced every year, and heavy crops are produced at irregular intervals.
- Seeds germinate readily and rapidly in nursery conditions after 25–30 days.
- No information about seedling development is available, and limited observations of growth rates are available only from cultivated trees.
- The large energy reserves present in the seeds are likely to assist early seedling establishment, and they are likely to have the capacity to persist in the forest understorey until conditions favour further growth. Development may be dependent on the formation of canopy gaps or the maintenance of a lightened canopy and midstorey on rainforest ecotones, including wet sclerophyll forest.
- The large seeds are assumed to be poorly dispersed, but may occasionally be dragged by rats and left unconsumed. Rodents are seed predators, but

movement of undamaged seeds from the parent tree has been observed in other rainforest trees, and may also occur for seeds of Endiandra floydii. Seeds will move by gravity on the steep slopes where some of the known populations are found. Floodwaters may move seeds in riparian sites (Barry & Thomas 1994).

Endiandra floydii was not recorded within the Subject Site. The proposed upgrade is not likely to disrupt the breeding cycle of a population as no known populations of the species would be impacted.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 7.7 ha of potential habitat for *Endiandra floydii*. The area to be directly impacted represents 0.3% of rainforest habitat in the local area (based on 776 ha from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that there are no known records of the species within the study area, the removal of 7.7 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Endiandra floydii* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation and 16 patches of Camphor Laurel in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed works is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Endiandra floydii* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be

created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 7.7 ha of potential habitat for *Endiandra floydii* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Draft Recovery Plan for *Endiandra floydii* has been prepared (DEC 2004h) and lists nine recovery objectives and a number of actions required to reach these objectives. Those relevant to the proposed upgrade include:

- To manage and protect *Endiandra floydii* and associated habitat from threatening processes – potential habitat for the species would be impacted by the proposed upgrade.
- Fire planning and management – the proposed upgrade would not alter the fire frequency of the local area.

Threats to the species include (DEC 2004h): low numbers; habitat clearing and fragmentation; development; weeds; grazing; roadside damage; poor regeneration; genetic problems; collection of propagation material; and, lack of information about threats.

The proposed upgrade is not likely to interfere with the recovery of Endiandra floydii, as the proposed upgrade does not impact any areas of known habitat.

Conclusion

Based on the above assessment, *Endiandra floydii* is unlikely to be significantly impacted by the proposed upgrade and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Gossia fragrantissima

Gossia fragrantissima is a multi-stemmed shrub or small tree, about 4 –10 m tall. The flowers are small, white and fragrant and are followed by small, round, yellow to orange berries (DEC 2005œ).

Gossia fragrantissima grows in dry subtropical rainforest and riverine rainforest

(Harden 2002, DEC 2005œ). The species can coppice from roots left in the ground when rainforest is cleared and is found at several sites as isolated plants in paddocks or regrowth (DEC 2005œ).

Gossia fragrantissima was not recorded in the study area.However, the species has been recorded in the local area, with:

- Two recordings approximately 3 km to the east of the proposed upgrade, along Piccadilly Hill Road;
- One recording approximately 750 m to the east of the proposed upgrade, east of Carney Place.
- Four recordings approximately 2.5 km to the north-west of the study area.

Potential habitat for *Gossia fragrantissima* in the study area occurs in Lowland Rainforest. The proposed upgrade would result in the removal of approximately 2.0 ha of Lowland Rainforest, with an additional 3.6 ha being indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Gossia fragrantissima was not recorded within the Subject Site during the current survey. No known records of *Gossia fragrantissima* would be impacted by the proposed upgrade, with the closest known records occurring approximately 750 m to the east of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Gossia fragrantissima* occurs in Lowland Rainforest in the study area.The removal of approximately 2.0 ha of vegetation that is potential habitat for *Gossia fragrantissima* is not likely to reduce the area of occupancy of the species, given that there are no known records of the species in the study area that would be impacted and that there is approximately 776 ha of potential habitat mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Gossia fragrantissima* would be impacted by the proposed upgrade, with the closest known record of *Gossia fragrantissima* occurring approximately 750 m to the east of the proposed upgrade. Potential habitat for *Gossia fragrantissima* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of Lowland Rainforest in a predominantly cleared landscape. The proposed upgrade would not result in the

fragmentation of any populations of *Gossia fragrantissima*.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Gossia fragrantissima* has been listed on the DEWHA Register of Critical Habitat. A Recovery Plan for *Gossia fragrantissima* is currently in preparation, but not yet available to the public.

The potential habitat for *Gossia fragrantissima* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

Gossia fragrantissima was not recorded within the Subject Site. The proposed upgrade is unlikely to disrupt the breeding cycle of a population given that there are no known populations in the impacted area.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Gossia fragrantissima*. The area to be directly impacted represents 0.3% of similar habitat types in the local area (based on 776 ha

from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that there are no known records of the species within the study area, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Gossia fragrantissima* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed works is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Gossia fragrantissima* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Gossia fragrantissima* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan for *Gossia fragrantissima* is currently in preparation and is not yet available to the public.

DEC (2005œ) lists nine priority actions to assist in the recovery of the species.

Those relevant to the proposed upgrade include:

- Undertake weed control in habitat areas – weed control works should be detailed in a Vegetation Management Plan.
- Conduct targeted surveys in habitat areas – the species was not recorded in potential habitat in the study area .

Threats to the species include (DEC 2005œ): habitat degradation through weed invasion and disturbance; loss of habitat through clearing and fragmentation; risk of local extinction because populations are small; and grazing by domestic stock.

The proposed upgrade is not likely to interfere with the recovery of Gossia fragrantissima, as the proposed upgrade does not impact any areas of known habitat.

Conclusion

Based on the above assessment, *Gossia fragrantissima* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Isoglossa eranthemoides

Isoglossa eranthemoides is a herb that grows to 50 cm tall, with paired leaves that are oval or more elongated and 2 – 16 cm long. The white-petalled flowers are about 12 mm across, and are borne in clusters towards the tops of the stems (DEC 2005).

Isoglossa eranthemoides occurs in the understorey of lowland subtropical rainforest, in moist situations on floodplains and slopes (DEC 2005).

Isoglossa eranthemoides has not been recorded in the study area.However, there are 13 previous records of the species within a 10 km radius of the study area, with the closest recording occurring approximately 2 km to the west of the study area.Potential habitat for *Isoglossa eranthemoides* occurs in Lowland Rainforest in the study area, 2.0 ha of which would be impacted by the proposed upgrade, with an additional 3.6 ha being indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Isoglossa eranthemoides was not recorded within the Subject Site during the current survey. No known records of *Isoglossa eranthemoides* would be impacted by the proposed upgrade, with the closest known record occurring approximately 2

km to the west of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Isoglossa eranthemoides* occurs in Lowland Rainforest in the study area.The removal of approximately 2.0 ha of vegetation that is potential habitat for *Isoglossa eranthemoides* is not likely to reduce the area of occupancy of the species, given that there are no known records of the species in the area that would be impacted and that there is approximately 776 ha of potential habitat mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Isoglossa eranthemoides* would be impacted by the proposed upgrade, with the closest known record of *Isoglossa eranthemoides* occurring approximately 2 km to the west of the proposed upgrade. The proposed upgrade would not result in the fragmentation of any populations of Isoglossa eranthemoides.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Isoglossa eranthemoides* has been listed on the DEWHA Register of Critical Habitat. A Recovery Plan for *Isoglossa eranthemoides* is currently in preparation, but not yet available to the public.

The potential habitat for *Isoglossa eranthemoides* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

Isoglossa eranthemoides was not recorded within the Subject Site. The proposed removal of approximately 2.0 ha of vegetation that is potential habitat for Isoglossa eranthemoides, with potential indirect impacts to a further 3.6 ha of potential habitat, is unlikely to disrupt the breeding cycle of a population, given that there are no known populations in the impacted area.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Isoglossa eranthemoides. The area to be directly impacted represents 0.3% of similar habitat types in the local area (based on 776 ha from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that there are no known records of the species within the study area, the removal of approximately 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Isoglossa eranthemoides* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed works is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Isoglossa eranthemoides* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 2.0 ha of potential habitat for *Isoglossa eranthemoides* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan for *Isoglossa eranthemoides* is currently in preparation and is not yet available to the public. The DECC (DEC 2005) propose a number of recovery actions that would assist in the recovery of the species. Of these, one is considered relevant to the proposed upgrade as follows:

- Protect areas of rainforest habitat from clearing or development – potential habitat for the species would be impacted by the proposed upgrade.

Threats to the species include (DEC 2005): risk of local extinction because populations small; clearing and fragmentation of habitat from development, agriculture and roadworks; construction of walking tracks in areas of habitat; weed infestation; grazing by stock; and inadvertent damage during bush regeneration.

The proposed upgrade is not likely to interfere with the recovery of Isoglossa eranthemoides, as the proposed upgrade does not impact any areas of known habitat.

Conclusion

Based on the above assessment, *Isoglossa eranthemoides* is unlikely to be significantly impacted by the proposed upgrade and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Ochrosia moorei

Ochrosia moorei is a small tree, sometimes crooked with several stems, growing up to 11 m tall. Small white flowers are held in small clusters at the ends of branchlets

(DEC 2005—).

Ochrosia moorei is found in riverine and lowland subtropical rainforest (DEC 2005—).

Ochrosia moorei was not recorded in the study area, however the species has been recorded within a 10 km radius of the study area, with the closest recording approximately 750 m to the west of the proposed upgrade, west of Tintenbar. Other recordings within 10 km radius of the study area include:

- Six recordings over 5 km to the east of the proposed upgrade, west and south-west of Bangalow.
- Three recordings over 7 km to the south-west of the proposed upgrade, west of Cumbalum.
- One recording approximately 5 km west of Ewingsdale.

Potential habitat for *Ochrosia moorei* occurs in Lowland Rainforest in the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with an additional 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Ochrosia moorei was not recorded within the Subject Site during the current survey. No known records of *Ochrosia moorei* would be impacted by the proposed upgrade, with the closest known records occurring approximately 1 km to the west of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Ochrosia moorei* occurs in Lowland Rainforest in the study area.The removal of approximately 2.0 ha of vegetation that is potential habitat for *Ochrosia moorei* is not likely to reduce the area of occupancy for the species, given that there are no known records of the species in the area that would be impacted and that there is approximately 776 ha mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Ochrosia moorei* would be impacted by the proposed upgrade, with the closest known record of *Ochrosia moorei* occurring approximately 750 m to the west of the proposed upgrade. The proposed upgrade

would not result in the fragmentation of any populations of *Ochrosia moorei*.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Ochrosia moorei* has been listed on the DEWHA Register of Critical Habitat. A Recovery Plan for *Ochrosia moorei* has not yet been prepared.

The potential habitat for *Ochrosia moorei* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

Ochrosia moorei was not recorded within the Subject Site. The proposed upgrade is unlikely to disrupt the breeding cycle of a population given that there are no known populations in the impacted area.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Ochrosia moorei*. The area to be directly impacted represents 0.3% of similar habitat types in the local area (based on 776 ha from NPWS

(1997b)). Given the relatively small area of habitat directly impacted, and the fact that there are no known records of the species within the study area, the removal of approximately 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Ochrosia moorei* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed works is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Ochrosia moorei* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 2.0 ha of potential habitat for *Ochrosia moorei* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan for *Ochrosia moorei* has not yet been prepared.

DEC (2005—) lists a number of actions to assist in recovery of the species. Those

relevant to the proposed upgrade include:

- Assist with the removal of introduced weeds – weed control should be detailed in a Vegetation Management Plan.
- Protect areas of rainforest habitat from clearing or development – potential habitat for the species will be cleared for the proposed upgrade.

Threats to the species include (DEC 2005—): clearing and fragmentation of habitat for coastal development, agriculture and roadworks; risk of local extinction because populations are small; invasion of habitat by introduced weeds; and collection of seed for horticulture.

The proposed upgrade is not likely to interfere with the recovery of *Ochrosia moorei*, as the proposed upgrade does not impact any areas of known habitat.

Conclusion

Based on the above assessment, *Ochrosia moorei* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Phaius australis

Phaius australis has flower stems up to 2 m tall and large broad leaves with a pleated appearance, both arising from a fleshy bulb near ground level. The large, showy flowers, with up to 20 per stem, have four petals which are white on the outside and brown with white or yellow veins on the inside. The central tongue of the flower is pink and yellow with lobes slightly curved inwards (DEC 2005˜).

Phaius australis is found in swamps dominated by Melaleuca quinquinerva, in sclerophyll forest, swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas (NSW Scientific Committee 1998c, DEC 2005˜).

Phaius australis has not been recorded in the study area.The species has, however, been recorded within a 10 km radius of the study area, with:

- Four recordings approximately 2 km east of the proposed upgrade, east and north-east of Bangalow.
- One recording approximately 9 km south-east of the proposed upgrade, south-east of Cumbalum.

Potential habitat for *Phaius australis* exists in Lowland Rainforest in the study area.The proposed upgrade would impact on approximately 5.6 ha of Lowland

Rainforest, with 2.0 ha directly cleared and 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Phaius australis was not recorded in the study area during the current survey. No known records of *Phaius australis* would be impacted by the proposed upgrade, with the closest known records occurring approximately 2 km east of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Phaius australis* occurs in Lowland Rainforest in the study area.The removal of approximately 2.0 ha of vegetation that is potential habitat for *Phaius australis* is not likely to reduce the area of occupancy of the species, given that there are no known records of the species in the area that would be impacted and there is a total of approximately 776 ha of Rainforest (potential habitat) in the local area.

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Phaius australis* would be impacted by the proposed upgrade, with the closest known record of *Phaius australis* occurring approximately 2 km to the east of the proposed upgrade. The proposed upgrade would not result in the fragmentation of any populations of Phaius australis.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or

ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Phaius australis* has been listed on the DEWHA Register of Critical Habitat. A Recovery Plan for *Phaius australis* is currently being prepared, but is not yet available to the public.

The potential habitat for *Phaius australis* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

Phaius australis was not recorded within the Subject Site. The proposed upgrade is unlikely to disrupt the breeding cycle of a population given that there are no known populations in the impacted area and there is at least 776 ha of similar potential habitat in the local area.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Phaius australis. The area to be directly impacted represents 0.3% of similar habitat types in the local area (based on 776 ha from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the amount of similar habitat in the local area (approximately 776 ha) and the fact that there are no known records of the species within the study area, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Phaius australis* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed works is not likely to modify, destroy, remove or isolate or decrease

the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Phaius australis* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of approximately 2.0 ha of potential habitat for *Phaius australis* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan for *Phaius australis* is currently being prepared, but is not yet available to the public.

A Draft Recovery Plan has been prepared for Phaius australis. The DECC (DEC 2005˜) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Protect areas of habitat from frequent fire – the proposed upgrade is not likely to change the fire frequency of the local area;
- Protect areas of habitat from pollution – runoff from the proposed upgrade may impact in adjoining areas of habitat;
- Control weeds – weed control works will be included as part of the Vegetation Management Plan; and,
- Protect areas of habitat from clearing, draining or development – potential habitat for the species will be cleared for the proposed upgrade.

Threats to the species include (DEC 2005˜): illegal collection for horticulture or cut flowers; clearing and fragmentation of habitat for development, agriculture and roadworks; drainage of swamps, or pollution from nutrient run-off; frequent fire;

grazing and trampling by domestic stock and feral pigs; and, invasion of habitat by introduced weeds.

The proposed upgrade is not likely to interfere with the recovery of Phaius australis, as the proposed upgrade does not impact any areas of known habitat.

Conclusion

Based on the above assessment, *Phaius australis* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Randia moorei

Randia moorei is a tall shrub or small tree to about 8 m tall, often with coppice shoots and root suckers at the base. Flowers are small and white, with a strong sweet smell, and develop into round yellow to orange berries which eventually turn black (DEC 2005™).

Randia moorei grows in subtropical, riverine, littoral and dry rainforest; north from Lismore (Harden 1992, DEC 2005™). In NSW, Hoop Pine and Brush Box are common canopy species (DEC 2005™).

Randia moorei has not been recorded in the study area.However, the species has been recorded within a 10 km radius of the study area, with five records approximately 7.7 km east of the proposed upgrade, in Broken Head Nature Reserve.

Potential habitat for the species exists in Lowland Rainforest in the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with an additional 3.6 ha being indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Randia moorei has not been recorded in the study area.No known records of *Randia moorei* would be impacted by the proposed upgrade, with the closest known records occurring approximately 7.5 km east of the proposed upgrade. The proposed upgrade is therefore not likely to lead to a long term decrease in the size of a population.

Is the action likely to reduce the area of occupancy of the species?

Potential habitat for *Randia moorei* occurs in Lowland Rainforest in the study area.The removal of approximately 2.0 ha of vegetation that is potential habitat for *Randia moorei* is not likely to reduce the area of occupancy of the species,

given that there are no known records of the species in the area that would be impacted and that there is approximately 776 ha of similar habitat in the local area (NPWS 1997b).

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Randia moorei* would be impacted by the proposed upgrade, with the closest known record of *Randia moorei* occurring approximately 7.5 km to the east of the proposed upgrade. The proposed upgrade would not result in the fragmentation of any populations of Randia moorei.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no critical habitat for *Randia moorei* has been listed on the DEWHA Register of Critical Habitat. A Recovery Plan for *Randia moorei* has been prepared (DEC 2004b), however the Recovery Plan does not list any areas of critical habitat for the species.

The potential habitat for *Randia moorei* that would be impacted by the proposed upgrade is not likely to be critical habitat, as the species was not recorded within the Subject Site and, as such, the impacted area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

Is the action likely to disrupt the breeding cycle of a population?

The following is a summary of the information about the life cycle of Randia moorei, detailed in the Recovery Plan for the species (DEC 2004b):

- Moderately slow growth rates have been observed in horticultural specimens of this species.
- The site at Brunswick Heads Nature Reserve is the largest known, with more than 60 individuals recorded. All size classes are represented at this site, occurring over a 0.4 ha area. Seedlings and/or small suckers are also present around several mature trees.
- *Randia moorei* coppices and produces root suckers readily, with suckers evident on many plants.
- The age at which *Randia moorei* is reproductively mature, and the time it takes the species to produce viable seed, are important biological variables. *Randia moorei* has been noted to fruit at six years old. Small shrubs (<1 m high) have been observed fruiting at Cudgera Creek and flower buds were present on a plant with a diameter at breat height <1 cm at Tony's Island.
- The flowering period of *Randia moorei* has been recorded as July to October.
- Flower buds were recorded in May at Tony's Island.
- Fruiting times appear to be irregular in Randia moorei. Ripe fruit has been recorded from July to August and December, as well as March from May to July and August.
- Fruit of the Rubiaceae family is readily dispersed by birds, although there are no known records of birds feeding on the fruit of Randia moorei. A proportion of the seeds are probably dispersed a distance from the parents and account for the scattered, isolated occurrences of plants which, seem to be typical of the Spiny Gardenia's distribution.
- Soil storage of seeds is likely to be transient in *Randia moorei* which is typical for species of later successional stages in rainforest environments.
- Seeds germinate readily after about three months and have a high rate of viability. However, seeds may lose viability quickly in the wild.

Randia moorei was not recorded within the Subject Site. The proposed upgrade is unlikely to disrupt the breeding cycle of a population given that there are no known populations in the impacted area.

Is the action likely to modify, destroy, remove or isolate or decrease the

availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Randia moorei. The area to be directly impacted represents 0.3% of similar habitat types in the local area (based on 776 ha from NPWS (1997b)). Given the relatively small area of habitat directly impacted and the fact that there are no known records of the species within the study area, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Randia moorei* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed works is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat?

The patches of vegetation within the Subject Site that are potential habitat for *Randia moorei* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Randia moorei* is not likely to introduce disease that may cause the species to decline. However as a precaution, construction vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

A Recovery Plan for *Randia moorei* has been prepared (DEC 2004b). Seven recovery objectives have been listed to assist in the recovery of the species. Of these, one is considered relevant to the proposed upgrade:

- To manage and protect *Randia moorei* populations and associated habitat – the proposed upgrade would result in clearing of potential habitat for the species.

Threats to the species include (DEC 2004b): habitat loss, habitat fragmentation, habitat degradation, weed removal, fire, mechanical disturbance, road maintenance, urban development and loss of genetic diversity.

The proposed upgrade is not likely to interfere with the recovery of Randia moorei, as the proposed upgrade does not impact any areas of known habitat.

Conclusion

Based on the above assessment, *Randia moorei* is unlikely to be significantly impacted by the proposed works and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Fauna

Three animal species listed as Endangered on the EPBC Act are considered to have potential habitat in the study area : Coxen's Fig Parrot, Spotted-tailed Quoll and Swift Parrot. One species, Mitchell's Rainforest Snail, listed as Critically Endangered on the EPBC Act is considered to have potential habitat in the study area.These animal species are assessed against the Significant Impact Criteria for Critically Endangered and Endangered species below.

Coxen's Fig-parrot ***Cyclopsitta diopthalma coxeni***

Coxen's Fig-parrots occur in lowland subtropical rainforests, in alluvial areas where figs and other fleshy-fruited trees are prevalent and preferred (Martindale 1986, Holmes 1990). Nests are constructed in tall tress usually within or near the edge of the rainforest and the ecotones between sclerophyll forest and subtropical rainforest.

Coxen's Fig Parrot was not recorded during the current or previous surveys within the study area.There is one record of the species in the Locality from 1987. There is one record from 1957 near Byron Bay, one from 1991 at Brunswick Heads and one

from 1993 in Lismore. The species is rarely seen, feeding quietly in the canopy and not flying often (Higgins 1999, NPWS 2002b).

Potential habitat for the Coxen's Fig-parrot occurs within the Lowland Rainforest. Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with an additional 3.6 ha indirectly impacted.

Will the action lead to a long-term decrease in the size of a population?

The Coxen's Fig-parrot was not recorded during the current surveys. The proposed upgrade would remove approximately 2.0 ha of potential habitat for this species (Lowland Subtropical Rainforest). This habitat has an extant area of 776 ha in the Locality and hence the amount to be removed represents 0.3 % of the extant area. Given the extent of potential habitat within the local region and the mobility of this species it is unlikely that the proposed upgrade would lead to a long-term decrease in the size of the population of this species.

Is the action likely to reduce the area of occupancy of the species?

There are no known records of Coxen's Fig Parrot in the study area.The proposed upgrade is likely to remove or modify approximately 5.6 ha (2.0 ha directly and 3.6 ha from indirect impacts) of potential habitat for this species. Given the extant of potential habitat within the local area (776 ha (NPWS 1997b)), the moderate quality of potential habitat in the study area and the high mobility of this species, it is unlikely that the proposed upgrade would result in a decrease of an area of occupancy for this species.

Is the action likely to fragment an existing population into two or more populations?

Potential habitat for this species is currently fragmented by agriculture, rural and residential development and associated infrastructure such as existing roads and electricity lines. The proposed upgrade would cut through sections of potential habitat for this species. However, no known populations occur in the study area and given the extent of potential habitat within the local region and mobility of this species, it is unlikely that the proposed upgrade would exaggerate fragmentation resulting in two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;

- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

Given the insufficient data on distribution, patterns of movement and ecology of the Coxen's Fig-parrot no habitat critical to the survival of this species has been defined, to date. Although important habitat features have been identified such as ecotones (nesting habitat) and Fig trees (foraging habitat), they are considered to occur in a range of habitats. Presumably, much of its preferred habitat of coastal rainforests or coastal subtropical rainforests has been lost by clearing, forcing it to move into upland rainforests and wet sclerophyll forests (NPWS 2002b).

The proposed upgrade is likely to remove and/or modify 5.6 ha (2.0 ha directly and 3.6 ha from indirect impacts) of potential habitat for this species, however habitat characteristics that would be removed are not considered to be limiting in the local or regional area and hence are not critical to the survival of the species.

Is the action likely to disrupt the breeding cycle of a population?

The breeding biology of Coxen's Fig-Parrot is very poorly known. The proposed upgrade is likely to impact approximately 5.6 ha of potential habitat for this species. However habitat characteristics such as breeding habitat that would be removed are not considered to be limiting in the local or regional area. For example the species nests in the limb or trunk of a dead tree, or a dead limb on a live tree, or in any exposed dead or rotting branch (Higgins 1999). Thus, given the relatively small proportion of potential habitat to be removed (0.3 %) it is unlikely that the action would disrupt the breeding cycle of this species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The removal of vegetation within the study area would contribute to the overall reduction in available habitat for the Coxen's Fig-parrot within Australia. The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for the species. The area to be directly impacted represents 0.3% of

similar habitat types in the local area (based on 776 ha from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that there are no known records of the species within the study area, the removal of approximately 2.0 ha of potential habitat is not likely to result in the decline of Coxen's Fig Parrot.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for Coxen's Fig Parrot that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation (Lowland Rainforest) in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed upgrade is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered/vulnerable species becoming established in the endangered or critically endangered species/vulnerable habitat?

The patches of vegetation within the Subject Site that are potential habitat for Coxen's Fig Parrot are generally in poor condition, due to the invasion of weeds and feral animals and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the reasoning that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

Diseases have not been identified as a threat to wild populations of the Coxen's Fig Parrot in the Coxen's Fig Parrot Recovery Plan, possibly due to insufficient knowledge of this species' ecology.

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. However, as the potential habitat for the Coxen's Fig Parrot in the study area is already degraded and fragmented by existing

roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species' decline.

Is the action likely to interfere with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act.

The DECC has prepared a list of priority actions to aid in the recovery of this species. Specific objectives of the Coxen's Fig Parrot Recovery Plan relevant to the proposed upgrade are to:

- Protect and maintain wild populations and their habitat from human-induced threatening processes in the long term;
- Protect and maintain the full genetic diversity of Coxen's Fig Parrot; and,
- Increase the extent, quality and connectivity of the habitat of Coxen's Fig Parrot.

The Recovery Plan details a host of recovery actions aimed at aiding Coxen's Fig Parrot on a number of fronts. The actions relevant to the proposed upgrade include protecting possible Fig Parrot foraging habitat that exists within Coxen's Fig Parrot's current range, including native fig trees that may be isolated.

The proposed upgrade is likely to remove approximately 2.0 ha of potential habitat for this species and impact a further 3.6 ha of potential habitat. The loss of habitat is considered as one of the major causes of decline in the Coxen's Fig Parrot Recovery Plan. However, given the relatively small proportion of potential habitat to be removed (0.3 %) within the Locality and proposed mitigation measures such as bush regeneration and using locally native species in landscaping, it is unlikely that the proposed upgrade would interfere with this species recovery. In addition, potential habitat within the study area is considered to be moderate quality and better quality potential habitat for this species occurs in other locations within the region (e.g. Whian Whian State Conservation Area, near Night Cap National Park). For these reasons it is unlikely that the Proposed Developed would interfere with the recovery of the Coxen's Fig Parrot.

Conclusion

Based on the above assessment, the Coxen's Fig Parrot is unlikely to be significantly impacted by the proposed upgrade and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Mitchell's Rainforest Snail ***Thersites mitchellae***

Mitchell's Rainforest Snail is listed as Critically Endangered by the EPBC Act and Endangered by the TSC Act. It is a large, native snail found exclusively in lowland rainforests and swamp sclerophyll forest with a rainforest understorey (NSW National Parks and Wildlife Service 2001). It is typically found in leaf litter on the forest floor, or occasionally under bark (NPWS 2005). It tends to occur on the margins of coastal wetlands (NSW National Parks and Wildlife Service 2001). Key habitat components for this species are a well-developed layer of leaf-litter for feeding and breeding, and an intact forest canopy to maintain a moist microclimate (NSW National Parks and Wildlife Service 2001).

Mitchell's Rainforest Snail has a restricted range, reflecting its specialised habitat requirements. It is restricted to the coastal plain between the Richmond and Tweed Rivers (NSW National Parks and Wildlife Service 2001). Within this area, the species is restricted to lowland subtropical rainforest and swamp schlerophyll forest with a rainforest understorey, typically on alluvial soils with a basaltic influence. It appears to be absent from other rainforest types. A population of several hundred snails occurs within Stotts Island Nature Reserve on the Tweed River and a complex of smaller populations around Cumbebin Wetland at Byron Bay. Other known populations of the species appear to be very small and are situated in small areas of habitat. The southern-most known population occurs near Lennox Head; thus, the study area is at the southern limit of the known distribution for this species.

Potential habitat for Mitchell's Rainforest Snail occurs within the patches of Lowland Rainforest within the study area.These patches are typically small, fragmented and affected by edge effects. Potential impacts of the Modified Ballina Bypass include the clearing of parts of the Lowland Rainforest and the alteration of the microclimate due to edge effects.

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population of the species?

There is no evidence that a population of Mitchell's Rainforest Snail occurs within the study area.This species is sedentary, restricted to patches of particular rainforest communities and probably dependant on rainforest with a relatively intact canopy and a well-developed layer of leaf litter. The patches of Lowland Rainforest within the study area are small and degraded by edge effects. The species can persist in narrow strips of remnant rainforest; however, its long-term viability at these sites is unknown.

Known populations of Mitchell's Rainforest Snail within the locality are scattered along patches of coastal rainforests 2 to 5 km to the east of the study area. The patches of Lowland Rainforest within the study area are fragmented and are

isolated from the populations to the east.

The proposed upgrade would remove approximately 2.0 ha of potential habitat for Mitchell's Rainforest Snail, which is less than 1% of the potential habitat occurring within the Locality. Given the degraded and fragmented nature of the areas to be cleared, it is considered that habitat loss would not lead to a long-term decrease in the size of a population of the species.

If Mitchell's Rainforest Snail occurs within the study area, the action would have the potential to directly impact such a population. However, there is no evidence of an existing or historic population within the study area and, given the habitat requirements of the species and location of known populations, it appears unlikely that the species would be utilising the study area.

Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?

The study area is located at the southern limit of the known distribution for this species; however there is no evidence of Mitchell's Rainforest Snail within the study area.The study area is isolated from the currently known populations of the species, which are located in rainforest patches closer to the coast. Within the wider region, populations of this species have been found at Stott's Island Nature Reserve near Murwillumbah and Cumbebin Wetland at Byron Bay as well as Tyagarah Nature Reserve (NSW National Parks and Wildlife Service 2001). It is therefore considered unlikely that the proposed upgrade would reduce the area of occupancy of this species.

Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?

The known populations of Mitchell's Rainforest Snail in the Locality occur in isolated patches of coastal Lowland Rainforest to the east of the study area.Within the study areathe potential habitat for this species is considered to be of poor quality, small, isolated stands of vegetation within cleared agricultural areas. The proposed upgrade is therefore unlikely to fragment an existing population of Mitchell's Rainforest Snail.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. There is no Critical Habitat for Mitchell's Rainforest Snail listed under the EPBC Act. However, Stotts Island Nature Reserve is listed as Critical Habitat for this species

under the provisions of the TSC Act and is included as Critical Habitat in the Recovery Plan for this species. The Recovery Plan produced by NPWS under the TSC Act has been adopted under the EPBC Act. Stotts Island Nature Reserve is located over 50 km north of the study area and the proposed upgrade would not adversely affect it.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population of the species?

The breeding biology of the Mitchell's Rainforest Snail is poorly known, with breeding behaviour only being observed once, when a clutch of eggs was laid just under the leaf litter on the rainforest floor (NPWS 2001b). Based on this observation and ecology of similar snails it is believed that a well-developed leaf litter layer (for foraging and breeding) and an intact forest canopy (to maintain a suitable microclimate) are key breeding habitat requirements (NPWS 2001b). The Lowland Rainforest remnants within the study area contain a moderately developed leaf litter layer and a generally intact canopy, although the small sizes of the fragments reduces the protection of their microclimate and connection with known populations.

If Mitchell's Rainforest Snail occurs within the study area, the action would have the potential to disrupt the breeding cycle of a population of this species. However, there is no evidence of an existing or historic population within the study area and, given the habitat requirements of the species and location of known populations, it appears unlikely that the species would be utilising the study area.

Is there a real chance or a possibility that the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Mitchell's Rainforest Snail is not known to occur in the study area.The potential habitat for the species within the study area exists in the form of small, isolated stands of vegetation within cleared agricultural areas. The proposed upgrade would result in the clearing of 2.0 ha of potential habitat, with additional edge effects impacting 3.6 ha of vegetation. Given the fragmented nature of the affected habitat, its poor quality and the absence of a known population within 2 km of the study area, it is considered highly unlikely that the proposed upgrade would further decrease the availability or quality of the potential habitat to the extent where the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Potential habitat for this species within the study area is degraded and already impacted by invasive species and edge effects. Road corridors are a known vector for invasive species and, in the absence of mitigation measures, have the potential to exacerbate existing weed infestations and increase edge effects. Of particular relevance is the potential to spread Lantana or invasive vines and scrambers, which are listed by the TSC Act as Key Threatening Processes that affect Lowland Rainforest.

Accordingly, mitigation measures have been proposed to reduce the impact of weed invasion and rehabilitate disturbed areas. Given the degraded nature of the existing habitat, the lack of evidence of the species in that habitat, and the proposed implementation of weed control measures, it appears unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Diseases have not been identified as a threat to populations of the Mitchell's Rainforest Snail by the Mitchell's Rainforest Snail Recovery Plan (NPWS 2001b). Die back or *Phytophthora* may have some potential to impact upon the habitat of Mitchell's Land Snail. *Phytophthora* causes defoliation of the canopy which would impact upon the moist microclimate required by Mitchell's Rainforest Snail. Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) is listed as a Key Threatening Process under the EPBC Act and TSC Act.

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. However, as the potential habitat for the Mitchell's Rainforest Snail in the study area is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species' decline.

Is there a real chance or a possibility that the action will interfere with the recovery of the species?

The Commonwealth Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A Recovery Plan for this species has been prepared under the TSC Act and has been adopted under the EPBC Act. The objectives of the plan are to assist in the identification of potential habitat and additional populations of Mitchell's Rainforest Snail, to improve the protection of known populations of this species, and to encourage community involvement in its

recovery.

Specific objectives of the Mitchell's Rainforest Snail Recovery Plan relevant to the proposed upgrade are to:

- Provide advice to relevant agencies and stakeholder groups on the conservation requirements and the location of known populations and potential habitat; and,
- Potential habitat (i.e. all lowland rainforest and swamp sclerophyll forest remnants and vegetated remnants) be protected within 50m of SEPP 14 coastal wetlands be protected from clearing or development in the relevant LEPs.

The proposed upgrade would result in the clearing of 2.0 ha of potential habitat and presumed edge effects into a further 3.6 ha of potential habitat. Clearing of habitat is identified as a threat to the recovery of the Mitchell's Rainforest Snail, and some of the Lowland Rainforest remnants identified in the study area occur within 50 m of SEPP 14 wetlands. However, these habitats are considered to be poor quality and isolated from areas of known habitat. For these reasons it is unlikely that the proposed upgrade would interfere with the recovery of the Mitchell's Rainforest Snail.

Conclusion:

Based on the above assessment, the Mitchell's Rainforest Snail is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Spotted-tailed Quoll *Dasyurus maculatus*

The Spotted-tailed Quoll is listed as Vulnerable on the TSC Act and Endangered on the EPBC Act. The Spotted-tailed Quoll is a large, marsupial carnivore. It has rich-rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly, with a distinguishable long, spotted tail. It consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects. It also eats carrion and takes domestic fowl. Two subspecies are currently recognised *Dasyurus maculatus gracilis* in north Queensland, and *D. m. maculatus* in the southeast of the mainland and Tasmania. Research suggests that Tasmanian and mainland tiger quolls form two distinct evolutionary units and a revised classification and management plan are needed for the species (Firestone *et al.* 1999). The subspecies of consideration in this report is *Dasyurus maculatus maculatus*.

The Spotted-tailed Quoll uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Breeding habitat requirements include suitable den sites, including hollow logs, hollow-bearing trees, rock crevices, rock cliff-faces and caves, and abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995).

Within the study area, potential foraging habitat exists within the EEC, Lowland Rainforest. This plant community in the study area occurs as small, fragmented stands and thus were considered to be in moderate condition. Rocky outcrops and caves are absent and fallen hollow logs and hollow-bearing trees are limited within the study area therefore it is expected that the area does not support important breeding habitat for the species. The main impacts on these habitats from the proposed upgrade would be clearing of habitat and sedimentation from runoff during construction. It is expected that these potential impacts would be minimised by the proposed mitigation measures.

The Spotted-tailed Quoll occurs on both sides of the Great Dividing Range, with a strong hold in the north east of NSW (NPWS 1999g). The Locality is towards the northern end of the species distribution with limited extension into south eastern Queensland.

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of population of the species?

Potential habitat for this species in the study area occurs within Lowland Rainforest (EEC). The patches of Lowland Rainforest within the study area are highly degraded, small and fragmented and, as such, impacted by edge effects. Although this species has been sighted in open grazing country or other isolated, treeless areas, it is considered that the species requires large tracts of relatively intact country to meet their foraging needs (NPWS 1999g). The potential habitat within the study area is considered to be poor quality and is already impacted by edge effects. The clearing proposed is unlikely to significantly increase the degradation of this potential habitat.

Approximately 2.0 ha of potential habitat for the species would be removed from study area.This represents less than 1% of potential habitat occurring within the Locality.

The proposed upgrade would affect a very small area of low quality potential habitat for this species. A large amount of higher quality potential habitat for this species exists within the Locality. The proposed upgrade would not further fragment areas of potential habitat in the study area or Locality. It is considered unlikely that the proposed upgrade would lead to a long-term decrease in the size of the population of the Spotted-tailed Quoll.

Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?

The Spotted-tailed Quoll has not been recorded in the study area, but has been recorded once within the Locality, within 100 m west of the southern end of the study area.Within the wider region, there are nearly 3,000 records of the Spotted-tailed Quoll in NSW with nearly 800 records occurring within the Northern Rivers Region (DECC Atlas; Bionet). These figures indicate that the species is not nearly as common in the Locality as it is in the region. If the Spotted-tailed Quoll is present within the study area, or has the potential to be, the small area to be cleared and the lack of further fragmentation effects caused by the proposed upgrade would make it unlikely that the area of occupancy of this species would be reduced as a result.

Is there a real chance or a possibility that the action will fragment an existing population of the species?

Potential habitat for the Spotted-tailed Quoll exists in the Locality in the form of small, isolated stands of vegetation within cleared agricultural areas. The proposed upgrade would result in the clearing of 2.0 ha of potential habitat. It is recognised that, employing a 50 m buffer area around the cleared area to include edge effects, impacts would extend the impact zone to 3.6 ha of vegetation. However, vegetation within the study area is poor quality and already impacted by edge effects. As such, the clearing proposed would not create any new edges and is unlikely to increase the degradation or fragmentation of the potential habitat within the study area.The proposed upgrade is therefore unlikely to fragment an existing population of Spotted-tailed Quoll.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. Critical Habitat has not been declared for the Spotted-tailed Quoll to date.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population of the species?

Given the large home ranges found in this species (often in excess of 850 ha (Webb 1993)), it is unlikely that a population is dependent on the study area for its survival. It is also unlikely the study area contains important breeding sites for the Spotted-tailed Quoll, as there are no rocky outcrops or caves present, and hollow trees and logs are limited. Therefore the proposed upgrade is unlikely to have a

significant impact on the breeding of this species.

Is there a real chance or a possibility that the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Potential habitat for the Spotted-tailed Quoll exists in the Locality in the form of small, isolated stands of vegetation within cleared agricultural areas. The proposed upgrade would result in the clearing of 2.0 ha of potential habitat, clearing no more than 50 m thickness areas into existing vegetation. It is recognised that, employing a 50 m buffer area around the cleared area to include edge effects, impacts would extend into a total of 3.6 ha of vegetation. However, vegetation within the study area is poor quality and already impacted by edge effects. As such the clearing proposed is unlikely to further decrease the availability or quality of the potential habitat within the study area to the extent where the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Road corridors are a known vector for invasive species; these are already recorded throughout the study area.Road corridors have the potential to exacerbate existing weed invasions in the impacted patches of vegetation, and increase edge effects. Vegetation within the study area is poor quality and already impacted by invasive species and edge effects. As such, the clearing proposed is unlikely to further degrade the potential habitat significantly. Mitigation measures have been proposed to reduce the impact of weed invasion. It is therefore unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

It has been suggested that the Spotted-tailed Quoll can contract parasites and diseases from cats. This is a difficult thing to quantify, especially in conditions where no antibodies are produced in the host species, or when antibodies are lost over time, however, most of these parasites and diseases probably have no significant effect on the Spotted-tailed Quoll (Dickman 1996). Two diseases are worth mentioning: *Spirometry erinacei*, a large pseudophyllidean tapeworm that infests the gut of carnivores, and *Toxoplasma gondii*, a protozoan parasite. Both parasites have been recorded in a range of native animals and can cause death, either directly or by reducing fitness and leaving an individual vulnerable to predation (Dickman 1996). *T. gondii* is implicated in the decline of some native animal populations however it is yet to be proven conclusively to be responsible for

population decline (Dickman 1996).

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. However, as the potential habitat for the Spotted-tailed Quoll is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species' decline.

Is there a real chance or a possibility that the action will interfere with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). A Recovery Plan for this species has not been prepared. The DECC has identified 32 priority actions to aid in the recovery of the species. Those most applicable to the proposed upgrade include:

- Identify sections of roads where Spotted-tailed Quolls are frequently killed on roads. Conduct a media campaign to ask for public records of road kills and use data held by the relevant government agencies;
- At sections of roads where Spotted-tailed Quolls are frequently killed, incorporate methods to reduce the numbers of animals killed. Assess the effectiveness of different mitigation methods. Erect signs in areas where road kills are common to alert drivers to the presence of Spotted-tailed Quolls; and,
- Retain and protect large, forested areas with hollow logs and rocky outcrops, particularly areas with thick understorey or dense vegetation along drainage lines.

The proposed upgrade would result in the clearing of 2.0 ha of potential habitat and presumed edge effects into a total impact zone of 3.6 ha of potential habitat. Although clearing of habitat is identified as a threat to the recovery of the Spotted-tailed Quoll, these habitats are considered to be poor quality. In addition, the proposed area to be cleared is less than 1% of the broader distribution of potential habitat in the Locality. For these reasons it is unlikely that the proposed upgrade would interfere with the recovery of the Spotted-tailed Quoll.

Conclusion:

Based on the above assessment, the Spotted-tailed Quoll is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the

provisions of the EPBC Act is not recommended for this species.

Vulnerable

Flora

Fourteen plant species listed as Vulnerable on the EPBC Act are considered to have potential habitat in the study area : *Arthraxon hispidus, Corokia whiteana, Desmodium acanthocladum, Endiandra hayesii, Floydia praealta, Hicksbeachia pinnatifolia, Macadamia tetraphylla, Marsdenia longiloba, Owenia cepiodora, Sophora fraseri, Syzygium hodgkinsoniae, S. moorei, S. paniculatum* and *Tinospora tinosporoides.* These plant species are assessed against the Significant Impact Criteria for Vulnerable species below:

Arthraxon hispidus

Based on the DEC threatened species profile (DEC 2005f), *Arthraxon hispidus* is a creeping grass with branching, erect to semi-erect purplish stems. Leaf-blades are 2–6 cm long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. This grass is considered to be a perennial but tends to die down in winter.

This species has not previously been recorded within the study area (Figure 3), but is known to occur approximately 1.5 km south of the proposed upgrade. Two additional records (Figure 3) of this species are located in the Locality (10 km radius) outside the study area approximately 9 km south west of Tintenbar.

Potential and known habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area, with approximately 2.0 ha of Lowland Rainforest directly impacted by the proposed upgrade and 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;

- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

One recording of this species exists within the study area, but will not be impacted by the proposed upgrade. This species has also been recorded from two locations within a 10 km radius of the study area.

The known distribution of this species is over a wide area in south-east Queensland, and on the Northern Tablelands and north coast of NSW (DEC 2005f). Recordings of this species within the study area are not considered to be at the limit of this species geographic range.

On the basis of the above, the proposed upgrade is not considered likely to lead to a long-term decrease in the size of an important population of a species.

Is the action likely to reduce the area of occupancy of an important population?

Known and potential habitat for *Arthraxon hispidus* occurs in Lowland Rainforest in the study area.The removal of 2.0 ha of vegetation that is potential habitat for *Arthraxon hispidus* is not considered likely to reduce the area of occupancy of the species, given that no know records would be impacted and that there is approximately 776 ha mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing important population into two or more populations?

No known records of the species would be impacted by the proposed upgrade; therefore no populations are likely to be fragmented or isolated. Numerous recordings of this species are present outside the study area and are broadly scattered on both sides of the proposed upgrade within a 10 km radius of the study area .

Known and potential habitat for *Arthraxon hispidus* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted.

On the basis of the above, the proposed upgrade is unlikely to result in the fragmentation of any populations of *Arthraxon hispidus* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

Little information is available on the breeding cycle of Arthraxon hispidus. On the basis that this species roots at the lower nodes (Royal Botanic Gardens Sydney

2006), it is assumed that reproduction is both asexual and by seed. As with other grasses, this species is assumed to be wind pollenated. The proposed upgrade is considered unlikely to impact on the breeding cycle of *Arthraxon hispidus* that are present within the study area and Locality as no known records of the species are likely to be impacted.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Arthraxon hispidus*. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005f). The patches of vegetation within the Subject Site that are potential habitat for *Arthraxon hispidus* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Arthraxon hispidus* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan or Threat Abatement Plan has been prepared for Arthraxon hispidus. The DECC (2005{) has identified a number of priority actions to help the recovery of this species. Those that are relevant to the proposed upgrade are detailed below:

- Protect habitat from frequent fire – the proposed upgrade is not likely to increase fire frequency in the local area.
- Avoid slashing or mowing around rainforest edges – the requirements of the species should be considered in the preparation of a Vegetation Management Plan.
- Control introduced grasses in areas with known populations – there are no known populations within the Subject Site. The Vegetation Management Plan should detail weed control works required in areas of known habitat for the species where they occur within RTA land.
- Protect areas of rainforest, wet eucalypt forest and swamp from clearing and development – the proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for the species.

The DECC (2005{) also lists the follow threats to this species:

- Clearing of habitat for agriculture and development;
- Inappropriate fire regimes;
- Over-grazing by domestic stock;
- Competition from introduced grasses such as Paspalum and Kikuyu; and,
- Slashing or mowing of habitat.

The proposed upgrade is not likely to interfere with the recovery of the species, as the proposed upgrade is not inconsistent with the above listed recovery actions and no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Arthraxon hispidus* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Corokia whiteana

This species has previously been recorded approximately 7 km to the north of the study area within a small isolated patch of Lowland Rainforest. There are no known records of the species within the patches of vegetation within the study area.

Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area, with approximately 2.0 ha of Lowland Rainforest directly impacted by the proposed upgrade and 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

The species was not recorded within the study area.The study area is therefore not likely to support an important population of the species. The proposed upgrade is therefore not considered likely to lead to a long-term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

The species was not recorded within the study area.The study area is therefore not likely to support an important population of the species. The proposed upgrade is therefore not considered likely to reduce the area of occupancy of an important population of the species.

Is the action likely to fragment an existing important population into two or more populations?

The species was not recorded within the study area.The study area is therefore not likely to support an important population of the species. The proposed upgrade is therefore not considered likely to fragment an existing important population into two or more populations.

Is the action likely to disrupt the breeding cycle of an important population?

The species was not recorded within the study area.The study area is therefore not likely to support an important population of the species. The proposed

upgrade is therefore not considered likely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Corokia whiteana*. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005f). The patches of vegetation within the Subject Site that are potential habitat for *Corokia whiteana* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edge effects will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Corokia whiteana* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared for Corokia whiteana. The DECC (DEC 2005j) has identified a number of actions to help the recovery of this species.

Those that are relevant to the proposed upgrade are detailed below:

- Protect rainforest areas from fire – the proposed upgrade is not likely to increase fire frequency in the local area.
- Control weeds in and around rainforest habitat – the Vegetation Management Plan will detail weed control works.
- Protect remaining habitat from clearing and timber harvesting – the proposed upgrade would result in the removal of potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of the species, as known habitat for the species will not be impacted.

Conclusion

Based on the above assessment, *Corokia whiteana* is unlikely to be significantly impacted by the proposed upgrade and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Desmodium acanthocladum

Desmodium acanthocladum is a sprawling shrub 1 – 2 m in height and often more than 2 m wide. The branches are rather rigid, though they commonly arch over other vegetation. The leaves are alternate up the stem and are divided into three leaflets, the middle one is longer than the other two and up to 2.5 cm in length. The branchlets are scattered with sharp spines. Pink or purple pea flowers are produced in summer and are followed by a sticky seed pod about 5 cm long (DEC 2005m).

This species occurs on basaltic soils and fringes of riverine subtropical rainforest. This species has not been recorded within the Subject Site, but has previously been recorded from at least eight locations to the west and north west of the study area.The nearest recording is approximately 6 km west of the proposed upgrade. Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with an additional 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Desmodium acanthocladum was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Desmodium acanthocladum was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Desmodium acanthocladum* would be impacted by the proposed upgrade. Potential habitat for *Desmodium acanthocladum* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Desmodium acanthocladum* or any potential habitat for the species.

The study area is not considered to contain an important population of Desmodium acanthocladum. The proposed upgrade is therefore not considered likely to fragment an important population of the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of Desmodium acanthocladum. The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Desmodium acanthocladum. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds especially Asparagus and Lantana has been identified as a threat to this species (DEC 2005m). The patches of vegetation within the Subject Site that are potential habitat for *Desmodium acanthocladum* are generally in poor condition, due to weed invasion and lack of vegetation structure. It is possible that the proposed upgrade would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. A number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Desmodium acanthocladum* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been written for Desmodium acanthocladum. The DECC (DEC 2005m) lists recovery actions for species. Those relevant to the project are listed below:

- Protect known populations during roadworks – there are no known populations of the species within the Subject Site;
- Control weeds – weed control works should be specified in the Vegetation Management Plan; and
- Protect known and potential habitat from clearing or development – no known habitat would be impacted by the proposed upgrade. Approximately 2.0 ha of potential habitat would be directly impacted by the proposed works.

The DECC (DEC 2005m) also lists the following threats to *Desmodium acanthocladum*:

- Clearing and fragmentation of habitat for agriculture or development;
- Damage to plants and habitat by roadworks;
- Browsing and trampling by stock; and,
- Weed infestation, particularly by introduced species such as Asparagus, and Lantana.

The proposed upgrade is not likely to interfere with the recovery of the species, as the proposed upgrade is not inconsistent with the above listed recovery actions and no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Desmodium acanthocladum* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Endiandra hayesii

Based on the DEC threatened species profile (DEC 2005t), *Endiandra hayesii* is usually a small crooked tree, but can sometimes grow to 35 m tall. It has grey to grey-brown bark, which is smooth or slightly scaly. The dull, hairy leaves are egg-shaped and measure 6 – 12 cm long and 3 – 6 cm wide. The leaves have a closely veined appearance. Flowers are small and white to pale green, and are held in small clusters. The fleshy fruits are egg-shaped, 2.5 – 3 cm long, and purplish-black when ripe.

This species has not been recorded in the study area, but has previously been recorded from five locations to east and west of the study area.The nearest recording is within a Lowland Rainforest remnant approximately 900 m east of the proposed upgrade immediately to the south of the Coolamon Scenic Drive and Pacific Hwy intersection. Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Endiandra hayesii was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Endiandra hayesii was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Endiandra hayesii* would be impacted by the proposed upgrade. Potential habitat for *Endiandra hayesii* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Endiandra hayesii* or any potential habitat for the species.

The study area is not considered to contain an important population of Endiandra hayesii. The proposed upgrade is therefore not considered likely to fragment an important population of the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of Endiandra hayesii. The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Endiandra hayesii. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds, especially Lantana and Camphor Laurel, has been identified as a threat to this species (DEC 2005t). The patches of vegetation within the Subject Site that are potential habitat for *Endiandra hayesii* are generally in poor condition, due to weed invasion and lack of vegetation structure. It is possible that the proposed upgrade would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. A number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Endiandra hayesii* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

A Recovery Plan has been prepared for *Endiandra hayesii* (DEC 2004e), and lists nine objectives to assist in the recovery of the species. Those relevant to the proposed upgrade include:

- To manage and protect *Endiandra hayesii* and associated habitat from threatening processes – potential habitat for the species would be impacted by the proposed upgrade; and,
- Fire planning and management – the proposed upgrade is not likely to alter the fire frequency within the Locality.

The Recovery Plan lists the following threats to *Endiandra hayesii* (DEC 2004e):

- Habitat clearing and fragmentation
- Loss of genetic variation
- Genetic issues

- Collection for the bush food and nursery industry.

Roads, and specifically Pacific Highway upgrades, are listed in the Recovery Plan as a mechanism that could increase the threat of fragmentation to the habitat Endiandra hayesii. The proposed upgrade would not increase fragmentation of habitat of Endiandra hayesii, as potential habitat that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any potential habitat for the species.

The proposed upgrade is not likely to interfere with the recovery of this species.

Conclusion

Based on the above assessment, *Endiandra hayesii* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Floydia praealta

Floydia praealta is a tree which grows to 35 m tall, with rough, brown, slightly wrinkled bark (DEC 2005v). It is closely related to the Macadamia. The leaves are 10 – 25 cm long and 1 – 3 cm wide, tapering at the bases but rounded at the tips, and with slightly wavy margins. They are shiny green and leathery, without hairs. The flower buds are creamy brown, and when open are cream and spidery with a musky odour. The woody, globular, brown fruit is 5 cm in diameter and contains one or two inedible seeds.

This species has not been recorded within the study area, but has previously been recorded from at least six locations to the north, south and west of the proposed upgrade. The nearest recording is approximately 1 km to the west of the proposed upgrade and immediately south of the Bangalow township. Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Floydia praealta was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Floydia praealta was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Floydia praealta* would be impacted by the proposed upgrade. Potential habitat for *Floydia praealta* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Floydia praealta* or any potential habitat for the species.

The study area is not considered to contain an important population of Floydia praealta. The proposed upgrade is therefore not considered likely fragment an important population of the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of Floydia praealta. The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Floydia praealta*. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds, especially Lantana and Camphor Laurel, has been identified as a threat to this species (DEC 2005t). The patches of vegetation within the Subject Site that are potential habitat for *Floydia praealta* are generally in poor condition, due to weed invasion and lack of vegetation structure. It is possible that the proposed upgrade would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. A number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Floydia praealta* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, a Recovery Plan has not been prepared for Floydia praealta. DECC (DEC 2005v) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Identify populations along roadsides and powerline easements and protect them during works – no *Floydia praealta* were identified in the study area.
- Remove weeds where they threaten adult plants or regeneration – weed control works should be detailed in a Vegetation Management Plan. There are no known roadside populations of the species in the study area .
- Protect areas of habitat from clearing or development – potential habitat for the species would be impacted by the proposed upgrade.

The DECC (DEC 2005v) also list the following threats to Floydia praealta:

- Clearing and fragmentation of habitat for coastal development, agriculture, roadworks and powerlines;

- Risk of local extinctions because populations are small and sparsely distributed;
- Infestation of habitat by weeds; and,
- Grazing and trampling of seedlings and saplings by domestic stock, particularly around remnant paddock trees.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Floydia praealta* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Hicksbeachia pinnatifolia

Hicksbeachia pinnatifolia is a small tree to 10 m tall, often with several unbranched stems rising from the rootstock (DEC 2005£). The leaves are leathery and compound, each 40 – 100 cm long, deeply lobed, or with many leaflets and a winged central spine. The lobes or leaflets have prickly toothed margins and the veins are prominent on both sides. A loose spike of many spidery-flowers, 15 – 35 cm long, arises directly from the trunk from ground level upwards. The flowers are purplish brown with a strong, sickly scent. Bright red fleshy fruits, 2 – 4 cm long, follow the flowers.

This species has not been recorded in the study area, but has previously been recorded from 11 locations. The nearest recordings are within 3 km to the west of the townships of Newrybar and Bangalow.

Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted by edge effects.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;

- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Hicksbeachia pinnatifolia was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Hicksbeachia pinnatifolia was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Hicksbeachia pinnatifolia* would be impacted by the proposed upgrade. Potential habitat for *Hicksbeachia pinnatifolia* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Hicksbeachia pinnatifolia* or any potential habitat for the species.

The study area is not considered to contain an important population of Hicksbeachia pinnatifolia. The proposed upgrade is therefore not considered likely to fragment an important population of the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of Hicksbeachia pinnatifolia. The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Hicksbeachia pinnatifolia. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in

existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds, especially Lantana and Camphor Laurel, has been identified as a threat to this species (DEC 2005t). The patches of vegetation within the Subject Site that are potential habitat for *Hicksbeachia pinnatifolia* are generally in poor condition, due to weed invasion and lack of vegetation structure. It is possible that the proposed upgrade would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. A number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Hicksbeachia pinnatifolia* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, a Recovery Plan for *Hicksbeachia pinnatifolia* has not been prepared. DECC (DEC 2005t) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Protect rainforest, moist eucalypt forest and Bush Box forest from fire - the proposed upgrade is not likely to alter the fire regime within the species habitat in the local area.
- Control introduced weeds - weed control works should be detailed in a Vegetation Management Plan.
- Protect remnant subtropical rainforest habitat – potential habitat for the species is required to be cleared as part of the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Hicksbeachia pinnatifolia* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Macadamia tetraphylla

Macadamia tetraphylla is a small to medium-sized, usually densely bushy, tree growing up to 18m tall. The leaves are 7 – 25 cm long and oblong or slightly lance-shaped. The leaf-margins are toothed and prickly. Creamy pink to purplish flowers hang in long strings among the leaves. The fruit is woody brown and globular, 2 – 3 cm in diameter. The edible seeds are enclosed in a hard, wrinkled, brown shell inside a round green husk. Most commercial macadamias are hybrids of this species and the Queensland species Macadamia integrifolia (DEC 2005*f*).

One known record of *Macadamia tetraphylla* is located within the study area.This record represents a planted individual in a garden landscape near Patch 12. This record would be indirectly impacted by the proposed upgrade, with no records directly impacted.

Potential habitat for this species is considered to be within Lowland Rainforest and Camphor Laurel which were recorded within the study area.It should also be noted that several recordings of this species occur within the Locality, many of which are within close proximity to commercial Macadamia plantations. Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted. In addition, 5.7 ha of Camphor Laurel would be impacted by the proposed upgrade, with a further 9.5 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

One individual *Macadamia tetraphylla* would be indirectly impacted by the proposed upgrade. The species has been recorded from at least four other locations within the study area outside the likely area of impact. This species has also been

recorded from numerous locations outside the study area.

The distribution of this species is predominantly between the Richmond and Tweed Rivers in north eastern NSW (DEC 2005*f*) although outlying records include south east Queensland to the north of the study area and Coffs Harbour to the South of the study area.Recordings of this species within the study area are considered to be at the limit of this species geographic range.

The proposed upgrade is not considered likely to lead to a long-term decrease in the size of an important population of a species, given that only one record is directly impacted.

Is the action likely to reduce the area of occupancy of an important population?

Known and potential habitat for *Macadamia tetraphylla* occurs in Lowland Rainforest in the study area.The removal of 7.7 ha of vegetation that is known and potential habitat for *Macadamia tetraphylla* is not considered likely to reduce the area of occupancy for the species, given the numerous records of the species in the local area and the fact that there is approximately 776 ha of similar habitat (Rainforest) in the local area (NPWS 1997b). In addition, there are large expanses of Camphor Laurel in the local area.

Is the action likely to fragment an existing important population into two or more populations?

Although one recorded individual may be directly impacted by the proposed upgrade, with an additional record likely to be indirectly impacted, no populations are likely to be fragmented or isolated. Numerous recordings of this species are present outside the study area on both sides of the proposed upgrade.

Known and potential habitat for *Macadamia tetraphylla* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted.

On the basis of the above, the proposed upgrade is unlikely to result in the fragmentation of any populations of *Macadamia tetraphylla* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

Pollination vectors in Macadamia species are known to be insects, especially bees (Heard 1993). The proposed upgrade is considered unlikely to impact on the dispersal of insect pollinators between *Macadamia tetraphylla* populations that are present within the study area and Locality. The proposed upgrade is therefore

considered unlikely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 7.7 ha of potential and known habitat for Macadamia tetraphylla. Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality (with 776 ha of Rainforest mapped as occurring in the local area by NPWS (1997b)), the removal of 7.7 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005*f*). The patches of vegetation within the Subject Site that are potential habitat for *Macadamia tetraphylla* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 7.7 ha of potential habitat for *Macadamia tetraphylla* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, a Recovery Plan has not been prepared for Macadamia tetraphylla. DECC (DEC 2005*f*) propose a number of recovery actions that would assist in the recovery of the species. Those relevant to the project include:

- Protect rainforest from fire – the proposed upgrade is not likely to alter the frequency of fire in the local area.
- Control weeds in rainforest areas - Weed control works should be detailed in the Vegetation Management Plan.
- Protect areas of rainforest habitat from clearing or development – potential habitat for the species would be impacted by the proposed upgrade.

The DECC (DEC 2005ƒ) also list the follow threats to the species:

- Clearing and fragmentation of habitat for coastal development agriculture and roadworks;
- Risk of local extinction due to low numbers;
- Grazing and trampling by domestic stock;
- Fire;
- Invasion of habitat by weeds; and,
- Loss of local genetic strains through hybridisation with commercial varieties.

The proposed upgrade is not likely to interfere with the recovery of the species, given the numerous records of the species in the local area only one of which would be indirectly impacted. Further, the indirect impacts will be minimised through mitigation measures.

Conclusion

Based on the above assessment, *Macadamia tetraphylla* is unlikely to be significantly impacted by the proposed upgrade and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Marsdenia longiloba

Marsdenia longiloba is a slender climber of the milk vine group, with pairs of very finely pointed leaves and 5-6 tiny glands at the base of the leaves. The stems of this species exude clear, watery sap when cut, unlike most of the milk vines which have milky sap. Clusters of small white star-shaped flowers are produced in summer and are followed by long, narrow seed-capsules that split to release many seeds with tufts of long silky hair (DEC 2005†).

This species has not been previously recorded in the study area, nor was it recorded during the current surveys. One recorded location of this species exists

approximately 6.4 km east of the proposed upgrade, and south west of the Byron Bay Township.

Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with an additional 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

This species was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Marsdenia longiloba has not been recorded in the study area in previous surveys, nor was it recorded in the current survey.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Marsdenia longiloba* would be impacted by the proposed upgrade. Potential habitat for *Marsdenia longiloba* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Marsdenia longiloba* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of Marsdenia longiloba. The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Marsdenia longiloba. The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005†). The patches of vegetation within the Subject Site that are potential habitat for *Marsdenia longiloba* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion, these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Marsdenia longiloba* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared for Marsdenia longiloba. The DECC (DEC 2005†) lists a number of recovery actions for this species. Those that apply to the study area include:

- Control weeds likely to spread into suitable habitat – Weed control works

should be detailed in a Vegetation Management Plan;

- Limit use of herbicides to areas away from significant native vegetation; and,
- Protect areas of habitat from clearing – potential habitat for the species would be impacted by the proposed upgrade.

The DECC (DEC 2005†) also list the follow threats:

- Loss and fragmentation of habitat through land clearing for agriculture; and urban development;
- Risk of local extinction because populations are small;
- Invasion of habitat by introduced weeds;.
- Grazing and trampling of plants by cattle; and
- Use of herbicides.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Marsdenia longiloba* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Owenia cepiodora

Owenia cepiodora is a tall evergreen tree, up to 30 m, with a dense glossy dark-green crown. Its bark is dark brown with vertical fissures. If the bark is cut, a pink-red underbark is exposed, and the tree exudes a red sap with a strong onion odour. The leaves are composed of 13 – 19 glossy dark green leaflets 10 – 15 cm long. Flowers are white, in clusters at the ends of branchlets. The globular red fruit are 15 – 20 mm wide, with white pulpy flesh surrounding a stone with one or two seeds. The timber resembles that of Red Cedar but has a characteristic onion odour (DEC 2005ˆ).

This species was not recorded in the study area (Figure 3). Five recorded locations of this species exist within 10 km of the study area, the closest occurring approximately 1.5 km west of the study area near the Tintenbar township.

Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland

Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

This species was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Owenia cepiodora was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Owenia cepiodora* would be impacted by the proposed upgrade. Potential habitat for *Owenia cepiodora* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Owenia cepiodora* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of *Owenia cepiodora*. The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for Owenia cepiodora. The area of habitat to be removed as part of

the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005†). The patches of vegetation within the Subject Site that are potential habitat for *Owenia cepiodora* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using local native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Owenia cepiodora* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared for Owenia cepiodora. The DECC (DEC 2005†) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Protect rainforest areas from fire – the proposed upgrade is not likely to change the fire frequency of the local area;
- Remove weeds where they threaten adult plants or regeneration – weed control works will be included as part of the Vegetation Management Plan; and,
- Protect areas of rainforest habitat from clearing or development – potential

habitat for the species will be cleared for the proposed upgrade.

The DECC (DEC 2005†) also list the follow threats:

- Clearing and fragmentation of habitat for development, agriculture, and road-works.
- Grazing by domestic stock;
- Fire;
- Invasion of habitat by weeds, especially Lantana;
- Weed invasion;
- Climate change;
- Activation of acid sulfate soils; and,
- Removal of dead wood.

The proposed upgrade is not likely to interfere with the recovery of the species, as no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Owenia cepiodora* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Sophora fraseri

Based on the DEC threatened species profile (DEC 2005–), *Sophora fraseri* is a is a small sparsely branched shrub growing 1 - 2 m tall, which belongs to the pea family. The whole plant is covered in soft short hairs. Its leaves are 6 - 15 cm long, and consist of 21 - 35 leaflets. The pale yellow flowers have the shape of a typical pea flower, and are arranged in groups at the ends of branches. The seed pods are 3 - 10 cm long and contain two to six seeds.

This species was not recorded within the Subject Site, and no previous recordings are known from within the study area (Figure 3). One recorded location of this species exists within 10 km of the study area and is located approximately 8 km to the south west Tintenbar.

Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland

Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

This species was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Sophora fraseri was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Sophora fraseri* would be impacted by the proposed upgrade. Potential habitat for *Sophora fraseri* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Sophora fraseri* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of *Sophora fraseri.* The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Sophora fraseri.* The area of habitat to be removed as part of

the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds, especially Lantana has been identified as a threat to this species (DEC 2005–). The patches of vegetation within the Subject Site that are potential habitat for *Sophora fraseri* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using local native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Sophora fraseri* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared for *Sophora fraseri.* The DECC (DEC 2005–) lists recovery actions for this species. Those relevant to the project include:

- Protect areas of habitat from frequent fire;
- Control weeds in and near habitat; and,
- Protect known and potential habitat from clearing and development.

The DECC (DEC 2005–) lists the follow threats to the species: loss of habitat through clearing for agriculture and development; timber harvesting activities; weed infestation, especially by Lantana; inappropriate fire regimes: regeneration from seed is stimulated by fire, but plants may be killed by fire before producing seed; and, risk of local extinction because populations are small.

The proposed upgrade is not likely to interfere with the recovery of the species, as the proposed upgrade is not inconsistent with the above listed recovery actions and no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Sophora fraseri* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Syzygium hodgkinsoniae

Syzygium hodgkinsoniae is a small tree to about 11 m tall. Its paired leaves are oval shaped or slightly elongated, 8 - 15 cm long, with a short blunt point at the tips. The flowers are off-white, fluffy and honey scented, about 25 mm in diameter, and are held in clusters at the ends of stems. The fruit are 4 cm in diameter, round and bright red. A thin layer of flesh, with a distinctive smell like that of an ashtray, encloses a single large seed (DEC 2005ž).

This species was not recorded within the Subject Site, and no previous recordings are known from within the study area (Figure 3). Numerous recorded locations are known within a 10 radius of the proposed upgrade, the closest being approximately 700 m to the west of the study area near Tintenbar.

Potential habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or

- populations that are near the limit of the species range.

This species was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

Syzygium hodgkinsoniae was not recorded in the study area.The study area is therefore unlikely to support an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

No known populations of *Syzygium hodgkinsoniae* would be impacted by the proposed upgrade. Potential habitat for *Syzygium hodgkinsoniae* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted. The proposed upgrade would not result in the fragmentation of any populations of *Syzygium hodgkinsoniae* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

The study area is not considered to contain an important population of *Syzygium hodgkinsoniae.* The proposed upgrade is therefore not considered likely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Syzygium hodgkinsoniae.* The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and

erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005ž). The patches of vegetation within the Subject Site that are potential habitat for *Syzygium hodgkinsoniae* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Syzygium hodgkinsoniae* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared for *Syzygium hodgkinsoniae.* The DECC (DEC 2005ž) lists a number of recovery actions for this species. Those relevant to the proposed upgrade include:

- Identify roadside trees and protect them during road-works – the species was not recorded within the Subject Site;
- Remove weeds in rainforest environments – weed control works will be included as part of the Vegetation Management Plan; and,
- Protect areas of suitable rainforest habitat from clearing or development – potential habitat for the species will be cleared for the proposed upgrade.

The proposed upgrade is not likely to interfere with the recovery of *Syzygium hodgkinsoniae*, as the proposed upgrade does not impact any areas of known habitat.

The DECC (DEC 2005ž) also lists the follow threats to the species:

- Clearing and fragmentation of habitat for development, agriculture, road-

works and powerlines;

- Weed infestation and general degradation of rainforest habitat;
- Grazing and trampling of seedlings and saplings by domestic stock;
- Roadside slashing and mowing; and,
- Illegal collection for horticulture.

The proposed upgrade is not likely to interfere with the recovery of the species, as the proposed upgrade is not inconsistent with the above listed recovery actions and no known habitat for the species would be impacted.

Conclusion

Based on the above assessment, *Syzygium hodgkinsoniae* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Syzygium moorei

Based on the DEC threatened species profile (DEC 2005Ÿ), *Syzygium moorei* is a tree growing up to 40 m tall, with dense dark foliage. The bark is red-brown, light grey or pinkish grey with soft papery scales. Its paired leaves are thick, oval-shaped or slightly elongated, 8 - 20 cm long, and usually rounded at the tips. Flowers are showy, pink to red, fluffy, and clustered directly on older leafless branches and the trunk of the tree. The white fleshy fruits are edible but rather tasteless. They have a diameter of up to 6 cm and enclose a single seed.

There are six records of this species in the study area including (Figure 2):

- One record in Patch 1, supporting 15 mature remnant trees. These trees would be indirectly impacted by the proposed upgrade;
- One record within Patch 5, occurring in a patch of Lowland Rainforest along the existing Pacific Highway. This record will be directly impacted;
- One record to the north of patch 7, which would be indirectly impacted;
- One record within the Patch 10, which is planted within a revegetated patch of Lowland Rainforest. This record would be indirectly impacted.
- One record to the south-west of Patch 14, occurring as a planted tree in a garden landscape. This record would be indirectly impacted

Potential and known habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Six recordings of this species exist within the study area, with one of these records directly impacted by the proposed upgrade. This species has also been recorded from numerous locations scattered within a 10 km radius of the study area.

The known distribution of this species is within Richmond, Tweed and Brunswick River valleys in north-east NSW and with limited occurrence in south-east Queensland (DEC 2005Ÿ). Recordings of this species within the study area are considered to be at or near the limit of this species geographic range.

Given the numerous records of the species in the local area, the direct removal of one known record is not likely to lead to a long-term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

Known and potential habitat for *Syzygium moorei* occurs in Lowland Rainforest in the study area.The removal of 2.0 ha of vegetation that is known and potential habitat for *Syzygium moorei* may reduce the area of occupancy of the species, with one known record directly impacted by the proposed upgrade. However, there are numerous recordings of the species in the local area and over 776 ha of known and potential habitat mapped as occurring in the local area (NPWS 1997b).

Is the action likely to fragment an existing important population into two or more populations?

Although one recorded individual may be directly impacted by the proposed upgrade, no populations are likely to be fragmented or isolated. Numerous

recordings of this species are present outside the study area on both sides of the proposed upgrade.

Known and potential habitat for *Syzygium moorei* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape, with only the edges impacted.

On the basis of the above, the proposed upgrade is unlikely to result in the fragmentation of any populations of *Syzygium moorei* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

Pollination and seed dispersal vectors in Syzigium species are known to include bats, birds and insects (Law 2001). Given the existing fragmented nature of the landscape and the small area of habitat to be impacted, the proposed upgrade is considered unlikely to impact on the dispersal of pollinators and seed dispersal vectors between *Syzygium moorei* populations that are present within the study area and Locality. The proposed upgrade is therefore considered unlikely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of known and potential habitat for *Syzygium moorei.* The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005Ÿ). The patches of vegetation within the Subject Site that are

potential habitat for *Syzygium moorei* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edge effects will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Syzygium moorei* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared for *Syzygium moorei.* The DECC (DEC 2005) has identified a number of priority actions to help the recovery of this species. Those relevant to the proposed upgrade include:

- Prevent fire from entering remnants containing *S. moorei* – the proposed upgrade is not likely to alter the fire frequency within the local area.
- Prevent further clearing and fragmentation of *S. moorei* habitat – habitat for the species will be cleared as part of the proposed upgrade.
- Control weeds in remnants containing *S. moorei* – weed control works will be detailed within the Vegetation Management Plan.

The DECC (DEC 2005) also lists the follow threats to this species:

- Clearing and fragmentation of habitat for development, agriculture and road-works;
- Weed infestation and general degradation of rainforest habitats;
- Grazing and trampling of seedlings and saplings by domestic stock; and,
- Illegal collection for horticulture.

The proposed upgrade is not likely to interfere with the recovery of the species, given the numerous recordings of the species over 776 ha of similar habitat mapped as occurring in the local area (NPWS 1997b).

Conclusion

Based on the above assessment, *Syzygium moorei* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Syzygium paniculatum

This species was not recorded within the study area, but has been recorded at two locations within a 10 km radius of the study area (Figure 3).

Habitat for this species is considered to be within Lowland Rainforest which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be directly impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted. No known records of the species would be impacted by the proposed upgrade.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Two recordings of this species exist within 10 km of the study area, none of which occur within the study area (Figure 3). The study area is therefore not likely to support an important population of the species.

The known distribution of this species is within between Nowra and Bulahdelah (DEC 2005„). Recordings of this species within the study area are considered to be north of the known limit of this species geographic range.

As the proposed upgrade would not result in the removal of any individuals of *Syzygium paniculatum,* the proposed upgrade is not likely to lead to a long-term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

The study area is not considered to support an important population of *Syzygium paniculatum.* Potential habitat for *Syzygium paniculatum* occurs in Lowland

Rainforest in the study area.The removal of 2.0 ha of vegetation that is potential habitat for *Syzygium paniculatum* is not likely to reduce the area of occupancy of an important population of the species.

Is the action likely to fragment an existing important population into two or more populations?

Syzygium paniculatum was not recorded in the study area.The study area is therefore unlikely to support an important population of the species.

Potential habitat for *Syzygium paniculatum* that will be disturbed as part of the proposed upgrade consists of small, fragmented patches of native vegetation in a predominantly cleared landscape (Figure 3).

On the basis of the above, the proposed upgrade is unlikely to result in the fragmentation of any important populations of *Syzygium paniculatum*.

Is the action likely to disrupt the breeding cycle of an important population?

Pollination and seed dispersal vectors in *Syzygium* species are known to include bats, birds and insects (Law 2001). The proposed upgrade is considered unlikely to impact on the dispersal of pollinators and seed dispersal vectors between *Syzygium paniculatum* populations that are present within the local area. The proposed upgrade is therefore considered unlikely to disrupt the breeding cycle of an important population of the species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 2.0 ha of potential habitat for *Syzygium paniculatum.* The area of habitat to be removed as part of the proposed upgrade equates to 0.3% of similar vegetation that exists in the Locality (based on 776 ha of Rainforest in the local area from NPWS (1997b)). Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 2.0 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Potential habitat for *Syzygium paniculatum* that will be disturbed as part of the proposed upgrade consists of small, isolated patches of native vegetation in a predominantly cleared landscape (Figure 3). The proposed upgrade would not result in the isolation of any potential habitat for the species.

The proposed upgrade is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005Ÿ) The patches of vegetation within the Subject Site that are potential habitat for *Syzygium paniculatum* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edge effects will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 2.0 ha of potential habitat for *Syzygium paniculatum* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

The DECC lists the follow threats to this species (DEC 2005„): loss of habitat through clearing for residential development; grazing and trampling of habitat by grazing stock; weeds, particularly Lantana, are invading the species' habitat; and,frequent fire.

To date, no Recovery Plan has been prepared for *Syzygium paniculatum.* The DECC (DEC 2005„) has identified a number of priority actions to help the recovery of this species. Those relevant to the proposed upgrade include:

- Protect known sites from fire; ensure that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat – the proposed upgrade is not likely to alter the fire frequency within the local area.

- Undertake weed control, but avoid spraying weeds close to *Syzygium paniculatum* plants to ensure they are not affected by poison – weed control works will be specified in the Vegetation Management Plan.

- Protect known habitat areas from clearing and disturbance – potential habitat for this species will be cleared by the proposed upgrade.

The proposed upgrade is not likely to impact on the recovery of the species, as the species is not known to occur in the study area and no known areas of habitat would be impacted.

Conclusion

Based on the above assessment, *Syzygium paniculatum* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Tinospora tinospoides

Based on the DEC threatened species profile (DEC 2005Ÿ), *Tinospora tinospoides* is a tall woody climber. The triangular leaves with broadly notched bases give the plant its common name (Arrow-head Vine), though leaf-shape varies through to oval. The leaves are thick, stiff, glossy, and are mostly 8 – 13 cm long. The leaf stalk is 5 – 12 cm long, with a swelling at each end, and a characteristic twist or angle at its junction with the stem. Male and female flowers are borne on separate plants, and are small and inconspicuous in long branched clusters. The fleshy fruits are produced in groups of three.

This species has previously been recorded within the study area (Figure 2), with:

- Two recordings in Patch 6, in a patch of Lowland Rainforest. One of these records will be directly impacted and,

- One record in Patch 14, in a patch of Lowland Rainforest, which will be indirectly impacted.

Tinospora tinospoides has also been recorded from numerous locations within a 10 km radius of the study area.

Potential and known habitat for this species is considered to be within Lowland Rainforest and Camphor Laurel which was recorded within the study area.Approximately 2.0 ha of Lowland Rainforest would be impacted by the proposed upgrade, with a further 3.6 ha indirectly impacted. In addition, approximately 5.7 ha of Camphor Laurel will be directly impacted, with a further 9.5 ha indirectly impacted.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Two recordings of this species may be impacted by the proposed upgrade, with one record directly impacted. This species has also been recorded from numerous locations scattered within a 10 km radius of the study area.

The known distribution of this species is north of the Richmond River in north-east NSW with limited occurrence in south-east Queensland (DEC 2005¥). Recordings of this species within the study area are considered to be at or near the limit of this species geographic range.

Given the numerous records of the species in the local area and the fact that only one of these will be directly impacted, the proposed upgrade is not considered likely to lead to a long-term decrease in the size of an important population of a species.

Is the action likely to reduce the area of occupancy of an important population?

Known and potential habitat for *Tinospora tinospoides* occurs in patches of Lowland Rainforest and Camphor Laurel in the study area.The removal of 7.7 ha of vegetation that is known and potential habitat for *Tinospora tinospoides* is not considered likely to reduce the area of occupancy of the species given the numerous records of the species in the local area and the fact that there is approximately 776 ha of general rainforest habitat mapped as occurring in the local area (NPWS 1997b). In addition, there are large expanses of Camphor Laurel in the local area.

Is the action likely to fragment an existing important population into two or more populations?

Although one record of this species may be directly impacted by the proposed upgrade, no populations are likely to be fragmented or isolated. Numerous recordings of this species are present outside the study area and are broadly

scattered on both sides of the Subject Site within a 10 km radius.

Known and potential habitat for *Tinospora tinospoides* that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of Lowland Rainforest and 16 patches of Camphor Laurel in a predominantly cleared landscape, with only the edges impacted.

On the basis of the above, the proposed upgrade is unlikely to result in the fragmentation of any populations of *Tinospora tinospoides* or any potential habitat for the species.

Is the action likely to disrupt the breeding cycle of an important population?

Little information is available on the breeding cycle of *Tinospora tinospoides.* On the basis that this species produces fleshy fruits (DEC 2005¥), it is assumed that as with other *Tinospora* species , seed dispersal of *T. tinosporoides* is via birds (Innis 1989a) and probably mammals such as bats. The proposed upgrade is considered unlikely to impact on such seed dispersal vectors between *Tinospora tinospoides* populations that are present within the study area and Locality.

The proposed upgrade is considered unlikely to disrupt the breeding cycle of a population, given that the species appears to be locally common within a 10 km radius and the likely modes of seed dispersal are not considered to be impacted by the proposed upgrade.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would result in the removal of approximately 7.7 ha of known and potential habitat for *Tinospora tinospoides.* There is approximately 776 ha of Lowland Rainforest mapped as occurring in the local area (NPWS 1997b). In addition, there are large expanses of Camphor Laurel in the local area. Given the relatively small area of habitat directly impacted, and the fact that larger expanses of habitat occur in the Locality, the removal of 7.7 ha of potential habitat is not likely to result in the decline of the species.

Indirect impacts to the potential habitat for the species include an increase in existing edge effects. Edge effects are on average likely to extend to approximately 50 m from the edge of a patch of vegetation (Biosis Research 2000). The patches of vegetation in the study area are already subject to edge effects. The implementation of mitigation measures, such as sedimentation and erosion controls and the Vegetation Management Plan, will minimise indirect impacts.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Infestation of habitat by introduced weeds has been identified as a threat to this species (DEC 2005¥) The patches of vegetation within the Subject Site that are potential habitat for *Tinospora tinospoides* are generally in poor condition, due to weed invasion and lack of vegetation structure. Given the highly modified nature of the patches of vegetation to be impacted by the proposed upgrade and the fact that no new edges will be created, it is unlikely that that proposed upgrade would result in an increase in invasive species. However, as a precaution, a number of recommendations have been made to reduce the impact of weed invasion; these include bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

The removal of 7.7 ha of potential habitat for *Tinospora tinospoides* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on sites near areas of native vegetation.

Is the action likely to interfere substantially with the recovery of the species?

To date, no Recovery Plan has been prepared *Tinospora tinosporoides.* The DECC (DEC 2005Ÿ) has identified the a number of priority actions to help the recovery of this species. Those relevant to the proposed upgrade include:

- Protect rainforest from fire – the proposed upgrade is not likely to alter the fire frequency of the local area;
- Control weeds in and near known habitat, taking particular care when other species of vine require cutting – weed control works should be detailed in a Vegetation Management Plan; and,
- Protect areas of habitat from clearing or development – potential habitat for the species will be cleared as part of the proposed works.

The DECC (DEC 2005Ÿ) also lists the follow threats to this species:

- Clearing and fragmentation of habitat for development, agriculture, and roads;
- Risk of local extinction because populations are small at some locations;
- Grazing and trampling by domestic stock;
- Fire;

- Invasion of habitat by introduced weeds; and,
- Accidental damage to plants when cutting introduced vines during bush regeneration.

With only one known record of the species directly impacted, the proposed upgrade is not likely to interfere with the recovery of the species given the local abundance of the species.

Conclusion

Based on the above assessment, *Tinospora tinospoides* is unlikely to be significantly impacted by the activities and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Fauna

Potential habitat for eight animal species listed as Vulnerable under the EPBC Act occurs in the study area :

- Australian Painted Snipe
- Eastern Long-eared Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Large-eared Pied Bat
- Long-nosed Potoroo
- Red Goshawk
- Three-toed Snake-tooth Skink

Australian Painted Snipe ***Rostratula australis***

The Australian Painted Snipe is usually found in shallow inland wetlands, either freshwater or brackish, that are permanently or temporarily filled. It is a cryptic bird that is hard to see and is often overlooked. It nests on the ground amongst tall reed-like vegetation near water and feeds near the water's edge and on mudflats, taking invertebrates, such as insects and worms, and seeds.

The Australian Painted Snipe has not been recorded in the study area.There is one record of the species in the Locality, south of the study area, near the mouth of the Richmond River.

Potential habitat for this species occurs in farm dams and depressions within the study area.The proposed upgrade will involve the removal of a small amount of potential foraging and nesting habitat for the Australian Painted Snipe. The main indirect impact on potential habitat as a result of the proposed upgrade would be an increase in edge effects, such as sedimentation from clearing and earthworks. With appropriate mitigation measures (e.g. sediment control) implemented, these potential impacts would be minimised.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

This species has not been recorded in the study area and there is only one record of the Painted Snipe in the Locality. The population within the Locality is not considered to be an important population. Potential habitat within the study area is restricted to farm dams and drainage depressions, some of which would be impacted by the proposed upgrade. Potential habitat for this species is well represented in the Locality and includes SEPP 14 wetlands (Cumbebin Swamp and Ballina Nature Reserve), creeks (Maguires, Simpson and Opossum Creeks) and farm dams. Given the mobility of this species, extent of potential habitat in the Locality, the small area of potential habitat affected within the study area and implementation of mitigation measures to limit indirect impacts, it is unlikely that the proposed upgrade would lead to a long term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

The population within the Locality is not considered to be an important population. The proposed upgrade is likely to modify or remove a small area of

potential habitat within the study area.This habitat is small, fragmented and degraded and highly unlikely to influence this species' occupation of the Locality.

Is the action likely to fragment an existing important population into two or more populations?

The population of Australian Painted Snipe in the Locality is not considered to be an important population. Potential habitat within the study area is already fragmented and the species is highly mobile. The proposed upgrade would not exaggerate the existing fragmentation of potential habitat for this species within the Locality.

Is the action likely to adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. 'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no areas of critical habitat have been listed for the Australian Painted Snipe. Potential habitat affected by the proposed upgrade is degraded and fragmented.

Is the action likely to disrupt the breeding cycle of an important population?

The population of Australian Painted Snipe in the Locality is not considered to be an important population. Given that there is only one record of the species in the Locality, it appears highly unlikely that the proposed upgrade would affect the

breeding cycle of this species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Potential habitat for the Australian Painted Snipe occurs within farm dams and drainage depressions within the study area.These habitats would be impacted by the proposed upgrade through either land clearing or edge effects. Potential habitat in the study area is considered to be in poor to moderate condition due to existing impacts from agricultural and residential use and is already impacted by edge effects. Potential habitat for this species is well represented in the Locality and includes SEPP 14 wetlands (Cumbebin Swamp and Ballina Nature Reserve), creeks (Maguires, Simpson and Opossum Creeks) and farm dams. Given the mobility of this species, extent of potential habitat in the Locality, the small area of potential habitat affected within the study area and implementation of mitigation measures to limit indirect impacts, it is unlikely that the proposed upgrade would lead to a long term decrease in the size of an important population of the species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Road corridors are a known vector for invasive species, some of which already occur within the Locality. It is possible that the proposed upgrade would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. A number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. Disease has not been listed as a threat causing the species to decline. The potential habitat for the Australian Painted Snipe in the study area is already degraded and fragmented by existing roads and agricultural use and it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species’ decline.

Is the action likely to interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act. To date, there is no Recovery

Plan for the Australian Painted Snipe. The proposed upgrade is unlikely to interfere with the recovery of this species.

Conclusion

Based on the above assessment, the Australian Painted Snipe is unlikely to be significantly impacted by the proposed upgrade and as such a referral under the provisions of the EPBC Act is not recommended for this species.

Eastern Long-eared Bat *Nyctophilus bifax*

The Eastern Long-eared Bat occurs in lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest (Strahan 1995a, Churchill 1998). The preferred habitat includes coastal rainforest and patches of coastal scrub (DEC 2005s). They roost in hollows in trees and also in the hanging foliage of palms, in dense clumps of foliage of rainforest trees and under bark (Churchill 1998, DEC 2005s).

It is unclear whether the species occurs within the study area ; bats of the *Nyctophilus* genus (i.e Long-eared Bats) were recorded by ultra-sonic detectors during the survey, but could be the common species *N. gouldi* or *N. geoffroyi*. The Eastern Long-eared Bat was not recorded within the study area during previous surveys. However, there are multiple (>10) records of this species within a 10 km radius of the study area.

The proposed upgrade would modify or remove approximately 5.7 ha (2.0 ha cleared and 3.6 ha affected by indirect impacts) of rainforest habitat. The main impacts on the Eastern Long-eared Bat would be potential for mortality of roosting bats during vegetation clearing, and the loss of foraging area and potential roost and maternity sites within the rainforest habitat.

Populations of the Eastern Long-eared Bat within the Locality could be regarded as important populations on the basis that the Locality is near the limit of the species main distributional range. This species occurs from Cape York through eastern Queensland to the far north-east corner of NSW. In NSW it is restricted to the coastal plain and nearby coastal ranges, extending south to the Clarence River area, with a few records further south around Coffs Harbour.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

The majority of records of the Eastern Long-eared Bat within the Locality occur in the coastal forests to the east, between Byron Bay and Lennox Head. There are also several records (outside the Locality) in the nearby Whian Whian State Forest and Nightcap National Park. The proposed upgrade would remove approximately

2.0 ha of potential forest habitat for the Eastern Long-eared Bat. The main impacts on the Eastern Long-eared Bat would be potential for mortality of roosting bats during vegetation clearing, and the loss of foraging area and potential roost and maternity sites within the rainforest habitat. This habitat type has an extant area of 776 ha (NPWS 1997b) within the Locality. The area to be removed therefore represents 0.3% of the extant area of potential habitat in the Locality. Proposed mitgation measures, such as sedimentation and erosion controls, should be employed to minimise indirect impacts (edge effects).

Given the mobility of this species, the extent of potential habitat within the Locality and evidence of existing habitat use elsewhere in the Locality, it is unlikely that the proposed upgrade would lead to a long-term decrease in the size of an important population.

Is the action likely to reduce the area of occupancy of an important population?

The proposed upgrade is likely to directly impact 2.0 ha of potential rainforest habitat for this species. This amount to be removed represents 0.3 % of the extant area of potential habitat in the Locality. This habitat is fragmented and unlikely to significantly influence this species' occupation of the Locality.

Is the action likely to fragment an existing important population into two or more populations?

Potential habitat for this species within the study area is currently fragmented by agriculture, rural and residential development and associated infrastructure. The species is relatively mobile. The proposed upgrade is unlikely to fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. 'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or

- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006b).

To date, no areas of critical habitat have been listed for the Eastern Long-eared Bat, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Is the action likely to disrupt the breeding cycle of an important population?

The proposed upgrade is likely to directly impact approximately 0.3% of potential habitat within the Locality. It is possible that this includes roosting or breeding sites. However, all confirmed records of this species are outside of the study area and it appears unlikely that the proposed upgrade would seriously affect the breeding potential of the population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade is likely to directly and indirectly impact approximately 0.7 % (5.6 ha) of potential habitat for this species within the Locality. Given the extent of potential habitat for the Eastern Long-eared Bat within the Locality it is unlikely that this habitat loss and modification would result in the decline of this species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Potential habitat within the study area has been previously disturbed; as such invasive species have been already recorded throughout the study area.It is possible that the proposed upgrade would exacerbate weed invasion in the study area.A number of recommendations have been made to reduce the impact of weed invasion, such as bush regeneration and using locally native species in landscaping.

Is the action likely to introduce disease that may cause the species to decline?

Road corridors have the potential to introduce or increase the incidence of external diseases into vegetation or populations. However, as the potential habitat for the Eastern Long-eared Bat in the study area is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed

upgrade would introduce new diseases into the area that could result in the species' decline.

Is the action likely to interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act. To date, no Recovery Plan has been prepared for the Eastern Long-eared Bat. The DECC has identified 20 priority actions and lists recovery actions for the species. Those most relevant to the proposed upgrade include:

- Protect hollow-bearing trees and patches of rainforest and other dense vegetation;
- Reconnect and rehabilitate patches of known and potential habitat;
- Reduce the use of pesticides and consider alternatives where available;
- Assist with removal of weeds, particularly with Bitou Bush control in coastal areas; and,
- Protect known and potential habitat, particularly low elevation rainforest and coastal scrub from clearing, fragmentation and isolation.

The proposed upgrade is likely to remove approximately 2.0 ha of potential habitat for this species and indirectly impact a further 3.6 ha of potential habitat. The loss of habitat is considered as one of the major causes of decline to the Eastern Long-eared Bat. However, given the relatively small proportion of potential habitat to be removed within the Locality and proposed mitigation measures (such as bush regeneration and using locally native species in landscaping), it is unlikely that the proposed upgrade would interfere with this species recovery. Potential habitat within the study area is limited and fragmented and better quality potential habitat for this species occurs in other locations within the region (e.g. conservation reserves). For these reasons it is unlikely that the Proposed Developed would interfere with the recovery of the Eastern Long-eared Bat.

Conclusion

Based on the above assessment, the Eastern Long-eared Bat is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Green and Golden Bell Frog *Litoria aurea*

The Green and Golden Bell Frog is known to occupy areas with a variety of habitat features throughout its range. There are, however, important habitat components which the species requires to survive, these include suitable water bodies for breeding, grassy surroundings for foraging and refuge, shelter sites, basking sites and over-wintering sites (Pyke and White 2001).

The species breeds in still or slow flowing water bodies, usually (but not always) with some aquatic emergent vegetation such as *Typha* spp. or *Eleocharis* spp. They will use exotic emergent vegetation. The Green and Golden Bell Frog forages amongst emergent aquatic or riparian vegetation and amongst vegetation, fallen timber adjacent to breeding habitat, including grassland, cropland and modified pastures.

The species has been recorded in Tyagarah Nature Reserve north of the study area, but the species is no longer considered to be present there (NPWS 1999d). In the wider region it has been recorded in Yuraygir National Park south of Iluka, and Hat Head National Park near South West Rocks. The species is not considered adequately represented in conservation reserves.

Potential habitat for this species exists in the study area in still or slow flowing water bodies, such as tributaries or farm dams with suitable aquatic and surrounding vegetation.

Since 1990 there have been approximately 50 recorded locations of this species in NSW, most of which are small, coastal, or near coastal populations (White and Pyke 1996).

This species is usually present in small, localised populations. One such population exists at Yuraygir National Park south of the study area, another in Clybucca, and another in the southern part of the region near Crescent Head.

This species is known in the Locality from four records from the 1980s scattered to the east of the study area.However, there are no known records north of Grafton since 1986 (DECC Recovery Plan).

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

There is no evidence of a population of the Green and Golden Bell Frog in the study area.The species was not detected during surveys. The nearest extant population occurs in Yuragir National Park. Records of the species do occur in Tyagarah National Park, Lake Ainsworth at Lennox Head and Kingsford Smith

Park at Ballina; however the species appears to have disappeared from these locations (DECC Recovery Plan).

Is the action likely to reduce the area of occupancy of an important population?

There is no evidence of a population of the Green and Golden Bell Frog in the study area.The species was not detected during surveys. The nearest extant population occurs in Yuragir National Park. Records of the species do occur in Tyagarah National Park, Lake Ainsworth at Lennox Head and Kingsford Smith Park at Ballina; however the species appears to have disappeared from these locations (DECC Recovery Plan). The habitat in the study area is unlikely to influence this species' area of occupancy.

Is the action likely to fragment an existing important population into two or more populations?

There is no evidence of a population of the Green and Golden Bell Frog in the study area.The species was not detected during surveys. The nearest extant population occurs in Yuragir National Park. Records of the species do occur in Tyagarah National Park, Lake Ainsworth at Lennox Head and Kingsford Smith Park at Ballina; however the species appears to have disappeared from these locations (DECC Recovery Plan).

Is the action likely to adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for the Green and Golden Bell Frog.

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological

community.

Such habitat may be, but is not limited to: habitat identified in a Recovery Plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, no areas of critical habitat have been listed for the Green and Golden Bell Frog, and therefore, the proposed upgrade is not likely to interfere with critical habitat.

Is the action likely to disrupt the breeding cycle of an important population?

The Green and Golden Bell Frog breeds in any still or slow flowing water bodies with some aquatic emergent vegetation. There is no evidence of a population of the Green and Golden Bell Frog in the study area.The species was not detected during surveys. The nearest extant population occurs in Yuragir National Park. Records of the species do occur in Tyagarah National Park, Lake Ainsworth at Lennox Head and Kingsford Smith Park at Ballina; however the species appears to have disappeared from these locations (DECC Recovery Plan). It is therefore unlikely that the proposed upgrade would disrupt the breeding cycle of a population of the Green and Golden Bell Frog.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Potential habitat for the Green and Golden Bell Frog exists in the Locality in the form of fragmented and degraded water bodies and associated wetlands within cleared agricultural areas.

There is no evidence of a population of the Green and Golden Bell Frog in the study area.The species was not detected during surveys. The nearest extant population occurs in Yuragir National Park. Records of the species do occur in Tyagarah National Park, Lake Ainsworth at Lennox Head and Kingsford Smith Park at Ballina; however the species appears to have disappeared from these locations (DECC Recovery Plan).

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The presence of the exotic predatory fish, Plague Minnow *Gambusia holbrooki* is

considered a factor affecting the long-term survival of the Green and Golden Bell Frog (Pyke and White 2001). While road corridors are a known vector for invasive species, roads are already present in the study area and it is likely that any negative impacts on the potential habitat from invasive species would already have occurred from these previous disturbances.

It is therefore unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is the action likely to introduce disease that may cause the species to decline?

Infection with the Chytrid fungus *Batrachochytrium dendrobatidis* is suspected to have contributed to the decline of the Green and Golden Bell Frog (DEC 2005o). This fungus is spread to new areas by contact with water or soil from contaminated areas. As roads are already present in the study area it is expected that any negative impacts on the local population from Chytrid fungus or other diseases/infections would already have occurred from these previous disturbances.

It is therefore unlikely that the proposed upgrade would introduce new diseases into the area.

Is the action likely to interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act.

The DECC has prepared a draft Recovery Plan for the Green and Golden Bell Frog (DEC 2005o). The objectives of this plan are to:

- Prevent the further loss of Green and Golden Bell Frog habitat at key populations across the species range;
- Protect extant populations from known threats; and,
- Implement habitat management.

The proposed upgrade would result in the clearing of less than 1% of potential habitat within the Locality. If a population of Green and Golden Bell Frogs occurs in the study area it would be considered a key population as it is at the northern extent of its range. However, there is no evidence of a population of the Green and Golden Bell Frog in the study area.The species was not detected during surveys. The nearest extant population occurs in Yuragir National Park.

Records of the species do occur in Tyagarah National Park, Lake Ainsworth at Lennox Head and Kingsford Smith Park at Ballina; however the species appears to have disappeared from these locations (DECC Recovery Plan). For these reasons it is unlikely that the proposed upgrade would interfere with the recovery of the Green and Golden Bell Frog.

Conclusion

Based on the above assessment, the Green and Golden Bell Frog is unlikely to be significantly impacted by the proposed upgrade and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-Fox is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, tall sclerophyll forests and woodlands, heaths and swamps, gardens and cultivated fruit crops. They forage opportunistically, often at distances up to 30 km from camps, and occasionally up to 60–70 km per night, in response to patchy food resources (NSW Scientific Committee, 2001). The species congregates in large numbers at roosting sites (camps). Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring.

The Grey-headed Flying-Fox was recorded within the study area during the current survey. It has been recorded multiple (>10) times in the Locality. Two camp sites are known to occur within the Locality, one just north of Ballina near the North Creek Canal and the other east of the proposed upgrade within the Radburn property, approximately 1 km north east of Hogans Bluff. Potential habitat for this species within the the study area includes rainforest and isolated trees or patches of trees. The proposed upgrade is likely to directly impact approximately 7.7 ha of this potential habitat with a further 20.8 ha potentially affected by indirect impacts.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

An ‘important population’ is defined by DEH (2006b) as a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or

- populations that are near the limit of the species range.

Grey-headed Flying-Foxes in northern and central NSW appear to function as a single breeding population. This population would be regarded as an important population. The species was recorded in the study area during the current surveys and two camp sites occur within the Locality. Therefore, the study area could be considered as providing potential habitat for an important population of this species. However, the proposed upgrade will directly impact only a small proportion of the potential habitat within the Locality (less than 1%). This species is capable of foraging in a broad range of vegetation types, including cultivated orchards and gardens. Given that there is no evidence of a camp site within the study area, it is highly unlikely that the proposed upgrade would result in a long-term decrease in population size.

Is the action likely to reduce the area of occupancy of an important population?

The important population referred to is distributed throughout northern and central NSW. The action would not reduce the area of occupancy of this population.

Is the action likely to fragment an existing important population into two or more populations?

The study area is already fragmented by existing residential and rural development and associated infrastructure. The proposed upgrade is unlikely to fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

To date, critical habitat has not been declared for the Grey-headed Flying-Fox.

Is the action likely to disrupt the breeding cycle of an important population?

The proposed upgrade is unlikely to impact any breeding roosts (camps). Therefore the proposed upgrade is unlikely to disrupt the breeding cycle of an important population of the Grey-headed Flying-Fox.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade is likely to directly impact approximately 7.7 ha of potential habitat, with a further 20.8 ha potentially affected by indirect impacts. This habitat is already fragmented and subjected to disturbance. The proposed upgrade is unlikely to further fragment or reduce the quality of the habitat. Given the range of this species and extent of potential habitat in the Locality, it is unlikely that the proposed upgrade would have a significant impact on the habitats for this species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Potential habitat within the study area has been previously disturbed and is subjected to ongoing disturbance including weed invasion. The proposed upgrade has the potential to exacerbate the existing weed invasion in the impacted patches of vegetation. Accordingly, mitigation measures such as bush regeneration and using locally native species in landscaping, are proposed in order to minimise these impacts.

Is the action likely to introduce disease that may cause the species to decline?

Road corridors have the potential to introduce or increase the incidence of external diseases into vegetation or populations. However, as the potential habitat for the Grey-headed Flying-fox in the study area is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area that could result in the species' decline.

Is the action likely to interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened

ecological communities listed under the EPBC Act. To date, no Recovery Plan has been prepared for the Grey-headed Flying-Fox. The DECC has identified 31 priority actions and lists recovery actions for the species. One of these involves the production of a National Recovery Plan for the species in 2007. The five key recovery strategies identified by the DECC include:

- Protect roost sites, particularly avoid disturbance from September through to November;
- Identify and protect key foraging areas;
- Manage and enforce licensed shooting;
- Investigate and promote alternative non-lethal crop protection mechanisms; and,
- Identify powerline blackspots and implement measures to reduce deaths.

The proposed upgrade is likely to remove approximately 7.7 ha of potential habitat for this species and impact a further 20.8 ha of potential habitat. The loss of habitat is considered as one of the major causes of decline to the Grey-headed Flying-Fox. However, given the relatively small proportion of potential habitat to be removed within the Locality and proposed mitigation measures such as bush regeneration and using locally native species in landscaping, it is unlikely that the proposed upgrade would interfere with this species' recovery.

Conclusion

Based on the above assessment, the Grey-headed Flying-fox is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Large-eared Pied Bat *Chalinolobus dwyeri*

The Large-eared Pied Bat is listed as Vulnerable by the TSC Act and Vulnerable by the EPBC Act. It is a small to medium-sized bat with long, prominent ears and glossy black fur. The lower body has broad, white fringes running under the wings and tail-membrane, meeting in a V-shape in the pubic area. This species is one of the wattled bats, with small lobes of skin between the ears and corner of the mouth.

The Large-eared Pied Bat is located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye 1995). The species can also be found on the edges of rainforests and

in wet sclerophyll forests (Churchill 1988). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1988).

Within the study area, potential foraging habitat for the Large-eared Pied Bat occurs mainly in Lowland Rainforest. This plant community occurs in the study area largely as fragmented stands within rural land. It is unknown whether the species would use the patches of Camphor Laurel within the study area.The species requires caves for breeding, which are not present in the study area.The main impact of the proposed upgrade would be clearing of potential foraging habitat.

The distribution of the Large-eared Pied Bat extends from south-east Queensland to the south coast of NSW and as far inland as the western slopes of the Great Dividing Range. The study area is not situated at the limit of the known distribution of this species.

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?

There is currently no evidence that a population of the Large-eared Pied Bat occurs within the Locality. The study area is probably marginal habitat for the species, given that they are generally recorded in drier woodlands.

Potential habitat for this species in the study area occurs within Lowland Rainforest. The patches of Lowland Rainforest within the study area are degraded, small and fragmented. Approximately 2.0 ha of potential habitat for the species would be removed from study area.This represents less than 1% of the potential habitat occurring within the Locality.

The proposed upgrade would affect a very small area of fragmented potential habitat for this species. The species has not been recorded in the Locality and potential roost sites are present. It is therefore considered unlikely that the proposed upgrade would lead to a long-term decrease in the size of an important population of the Large-eared Pied Bat.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. The species has not been recorded in the study area or Locality. If a population of this species is present in the study area, it is not considered an important population

based on the low quality and small size of potential habitat available, and the paucity of records of this species in the study area and Locality compared to the wider region. The study area is not near or at the limits of the species' known distribution.

However, if there is a Large-eared Pied Bat population within the study area, it is highly unlikely that removal of a small area of potential foraging habitat would influence its occupation of the Locality of region.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

Potential habitat within the study area is already fragmented. It is not anticipated that the proposed upgrade would exaggerate the existing fragmentation of potential habitat for this species within the Locality.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for the Large-eared Pied Bat.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

The Large-eared Pied Bat requires caves for breeding, which are not present in the study area.The study area is unlikely to support a large maternal breeding colony and the proposed upgrade is unlikely to significantly affect the species' breeding cycle.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade would require clearing of potential foraging habitat for the Large-eared Pied Bat. Approximately 2.0 ha of Lowland Rainforest (which is potential foraging habitat for the Large-eared Pied Bat) would be removed (with indirect impacts creating a total impact zone of 3.6 ha). This represents less than 1% of potential habitat which occurs within the Locality.

It is unlikely that the proposed upgrade would decrease the availability or quality of the potential habitat within the study area to the extent that the species is likely

to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Road corridors are a known vector for invasive species; these are already recorded throughout the study area.Road corridors have the potential to exacerbate existing weed invasions in the impacted patches of vegetation, and increase edge effects. Vegetation within the study area is poor quality and already impacted by invasive species and edge effects. As such, the clearing proposed is unlikely to further degrade the potential habitat significantly. Mitigation measures have been proposed to reduce the impact of weed invasion. It is therefore unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Diseases have not been identified as a threat to populations of the Large-eared Pied Bat.

Road corridors have the potential to introduce or increase the incidence of external diseases into vegetation or populations. However, as the potential habitat for the Large-eared Pied Bat in the study area is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species' decline.

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act. A Recovery Plan for the Large-eared Pied Bat has not been prepared to date.

The DECC lists 17 priority actions to help recover the Large-eared Pied Bat. One of these involves the need to identify the effects of fragmentation on the species in a range of fragmented landscapes such as the farmland/forest interface. Given there is currently no evidence that a population of the Large-eared Pied Bat occurs within the Locality, only a small proportion of potential habitat would be cleared and no caves for breeding are present in the study area, it is unlikely the proposed

upgrade would interfere with the species' recovery.

Conclusion

Based on the above assessment, the Large-eared Pied Bat is unlikely to be significantly impacted by the proposed upgrade. A Referral under the provisions of the EPBC Act is not recommended for this species.

Long-nosed Potoroo *Potorous tridactylus*

The Long-nosed Potoroo is a mainly nocturnal, medium sized mammal (up to 1.6 kg). Its fur is greyish-brown on top and paler underneath, and the snout is long and tapering (Strahan 1995). The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet, which also includes roots, tubers, insects and their larvae and other soft-bodied animals in the soil. The species often digs small holes in the ground in a similar way to bandicoots.

The Long-nosed Potoroo inhabits coastal heaths and dry and wet sclerophyll forests (Strhan 1995). Dense understorey with occasional open areas is an essential part of their habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The species requires rainforest or vegetation with dense understorey for breeding. In NSW it is generally restricted to coastal heaths and forests east of the Great Dividing Range with an annual rainfall exceeding 760 mm. The Locality is towards the northern end of the species distribution. Although the species has not been recorded in the study area, it has been recorded multiple (>10) times in the Locality.

Potential habitat for this species in the study area occurs in the Lowland Rainforest plant community. The plant communities in the study area are degraded and fragmented. The main impacts of the proposed upgrade would be clearing of habitat and edge effects. It is expected that edge effects would be minimised by the implementation of mitigation measures.

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?

An 'important population' is defined by DEH (2006b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in Recovery Plans, and/or that are:

- key source populations either for breeding or dispersal;

- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

The Cobaki Lakes and Tweed Heads West population of the Long-nosed Potoroo in the Tweed local government area has been listed as an Endangered Population in Part 2 of Schedule 1 of the TSC Act. This population does not include the populations or habitat in the Locality and is unlikely to be impacted by the proposed upgrade.

The Long-nosed Potoroo was not recorded in the study area.Records within the Locality mainly occur in coastal vegetation north of Byron Bay. It is not considered likely that the proposed upgrade would lead to a decrease in the size of any important population of the Long-nosed Potoroo.

The proposed upgrade would affect a very small area of low quality potential habitat for this species. A large amount of higher quality potential habitat for this species exists within the Locality. It is not considered likely that the proposed upgrade would lead to a decrease in the size of any important population of the Long-nosed Potoroo.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?

The Long-nosed Potoroo has not been recorded in the study area, but has been recorded within the Locality. No known population of the species would be impacted by the proposed upgrade. Within the Locality the species appears to mainly occur in large tracts of coastal forest, rather than in scattered fragments like that within the study area.Potential habitat for this species in the study area occurs within Lowland Rainforest. The patches of Lowland Rainforest within the study area are degraded, small and fragmented and, as such, already impacted by edge effects. Although this species has been sighted in open grazing country or other isolated, treeless areas, it is considered that the species requires large tracts of relatively intact country to meet their foraging needs (NPWS 1999g). It is unlikely that the area of occupancy of this species would be reduced by the proposed upgrade.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

Potential habitat for the Long-nosed Potoroo within the study area occurs as small, isolated stands of vegetation within cleared agricultural areas. The landscape is already highly fragmented and impacted by edge effects. The vast majority of records of the species occur in larger patches of coastal vegetation to

the east of the study area.The proposed upgrade is therefore unlikely to fragment an existing population of Long-nosed Potoroo.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date, no critical habitat has not been declared for the Long-nosed Potoroo.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

The Long-nosed Potoroo requires rainforest or vegetation with a dense understorey for breeding. In NSW, breeding peaks typically occur in late winter to early summer. While mainly solitary, they are non-territorial and hold small home ranges (2-5 ha). The proposed upgrade will affect a very small area of low quality potential habitat for this species. A large amount of higher quality potential habitat for this species exists within the Locality. The Long-nosed Potoroo was not recorded in the study area and it is unlikely that a population is dependent on the study area for its survival. Therefore the proposed upgrade is unlikely to have a significant impact on the breeding of this species.

Is there a real chance or a possibility that the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Potential habitat for the Long-nosed Potoroo exists in the study area in the form of small, isolated stands of vegetation within cleared agricultural areas. The proposed upgrade would result in the clearing of 2.0 ha of potential habitat, with a further 3.6 ha potentially affected by edge effects. The patches of Lowland Rainforest within the study area are degraded, small and fragmented and, as such, already impacted by edge effects. The proposed upgrade is unlikely to further decrease the availability or quality of the potential habitat within the study area to the extent where the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Road corridors are a known vector for invasive species; these are already recorded throughout the study area.Road corridors have the potential to exacerbate existing weed invasions in the impacted patches of vegetation, and increase edge effects.

Vegetation within the study area is moderate or poor quality and already impacted by invasive species and edge effects. As such, the clearing proposed is unlikely to further degrade the potential habitat significantly. Mitigation measures have been proposed to reduce the impact of weed invasion. It is therefore unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. However, as the potential habitat for the Long-nosed Potoroo is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species' decline.

One disease, *Toxoplasma gondii* (a protozoan parasite) has been recorded in a range of native animals and can cause death, either directly or by reducing fitness and leaving an individual vulnerable to predation (Dickman 1996). *T. gondii* is implicated in the decline of some native animal populations; however, it is yet to be proven conclusively to be responsible for population decline (Dickman 1996).

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment and Water Resourses may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). To date no Recovery Plan has been prepared for the Long-nosed Potoroo. The DECC has identified 19 priority actions and lists recovery actions for the species. Those most applicable to the proposed upgrade include:

- Increase habitat via revegetation work and/or establishing corridors to link multiple patches of suitable habitat to expand the effective area of habitat; and,

- Protect and maintain habitat, especially dense understorey. Provide linkages across the broader landscape.

The proposed upgrade would result in the clearing of less than 1% of the potential habitat in the Locality. It is unlikely that the proposed upgrade would interfere

with the recovery of the Long-nosed Potoroo.

Conclusion:

Based on the above assessment, the Long-nosed Potoroo is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Red Goshawk ***Erythrotriorchis radiatus***

The Red Goshawk is a large, long-winged hawk which occurs in forests and woodland in north-eastern and north Australia (Slater et al. 2003). It is most often seen in association with northern woodlands, tree-lined waterways, crossing grasslands or shrublands (Olsen 1995). This species has a very large territory, perhaps 120-200 km^2 (Olsen 1995).

There are two records of the Red Goshawk within the Locality, near the Richmond River. Potential habitat for the species occurs within the study area along tree-lined waterways (Lowland Rainforest) such as creeks and streams, with potential foraging habitat in adjacent agricultural grassland (the Red Goshawk prefers to forage on floodplains interspersed with dense forest and open woodland). The main impact of the proposed upgrade would be the clearing of potential habitat.

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?

If a population of the Red Goshawk occurs in the study areaand adjacent land it is not considered to be an important population for the following reasons:

- it is unlikely to be a key source population either for breeding or dispersal as this species is considered mainly sedentary (within its large range) and breeding has only been recorded once in the vicinity of the study area, in the Lismore area (Marchant and Higgins 1993b);
- it is unlikely to be necessary for maintaining genetic diversity, as there is no evidence that the study area contains an isolated genetic variant of this species or that the proposed upgrade would impact on the overall genetic diversity of the species; and,
- the study area is not at or near the limit of the species range, which extends south to the Hunter Valley, although the distribution in NSW is very sparse (DEC 2005Œ).

The Red Goshawk has not been recorded in the study area during previous surveys, not was it recorded during the current survey.The study area is therefore unlikely to support an important population of this species. If a population of the Red Goshawk is present in the study area it is not considered to be an important population. There is one record from the Locality. It is not considered likely that the proposed upgrade would lead to a decrease in the size of any important population of the Red Goshawk.

Potential habitat for this species exists in the study area within Lowland Rainforest along waterways such as creeks and streams, with potential foraging habitat in adjacent agricultural grassland. These vegetation types are present only as fragmented patches in the study area which are of moderate quality. This habitat is of limited use to the Red Goshawk which prefers to forage in continuous forested areas within ecotones (Marchant and Higgins 1993b). In addition, as the vegetation within the study area is already impacted by edge effects, the proposed upgrade is unlikely to increase the degradation of the these potential habitats.

Approximately 2.0 ha of potential Lowland Rainforest habitat for the species would be removed from 746 ha in the Locality. This represents 0.3% of potential habitat occurring within the Locality.

Given the small area and low quality of habitat to be cleared, the large amount of potential habitat within the Locality, the lack of further fragmentation caused by the proposed upgrade and the species wide range and high mobility, it is considered unlikely that the proposed upgrade would lead to a long-term decrease in the size of the population of the Red Goshawk.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?

If a population of the Red Goshawk is present in the study area it is not considered to be an important population. The proposed upgrade would entail the removal of approximately 2.0 ha of Lowland Rainforest which provides potential habitat for this species. Some additional waterside habitat and grassland will also be removed. This represents less than 1% of potential habitat which occurs within the Locality.

The potential habitat within the study area is considered to be moderate to poor quality and the proposed upgrade is unlikely to cause significant further fragmentation effects. In addition, higher quality habitat exists elsewhere in the region (e.g. within the protected areas Boat Harbour Nature Reserve, Tuckean Nature Reserve, Bundjalung National Park, Braemar State Forest, and Nightcap National Park) and it is unlikely that the study area holds important core habitat in the species' area of occupancy. Given the above, it is unlikely that the area of

occupancy of this species would be reduced as a result of the proposed upgrade.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

If a population of Red Goshawk occurs in the study area it is not considered to be an important population. Furthermore potential habitat within the study area is already fragmented. It is not anticipated that the proposed upgrade would exaggerate the existing fragmentation of potential habitat for this species within the local area.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for the Red Goshawk; therefore the proposed upgrade is unlikely to affect critical habitat of the species.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

If a population of Red Goshawk occurs in the study area it is not considered to be an important population. Little is known about the breeding biology of the Red Goshawk although breeding is thought to occur in forested areas, usually within 1 km of water. Nests are normally constructed in a tall riparian tree (DEC 2005Œ) (Marchant and Higgins 1993b). While the proposed upgrade would entail removal of potential breeding habitat, this potential habitat is considered to be moderate to poor quality, the area proposed to be cleared is relatively small and the proposed upgrade is unlikely to cause significant further fragmentation effects. In addition, breeding has only been recorded once in the vicinity of the study area, in the Lismore area (> 20 km from the study area) (Marchant and Higgins 1993b). It is therefore unlikely that the proposed upgrade would disrupt the breeding cycle of a population of the Red Goshawk.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Potential habitat for the Red Goshawk exists in the study area and Locality in the form of small isolated stands of vegetation within cleared agricultural areas. This habitat is of limited use to the Red Goshawk which prefers to forage in continuous forested areas within ecotones (Marchant and Higgins 1993b). The proposed

upgrade would result in the clearing of 2.0 ha of potential Lowland Rainforest habitat, clearing no more than 50 m thickness areas into existing vegetation. Vegetation within the study area is moderate to poor quality and already impacted by edge effects.

Higher quality habitats in the form of continuous vegetation mosaics (Marchant and Higgins 1993b) are available within conservation reserves and other areas within the region. Records of the species in protected areas of the region within the protected areas (Boat Harbour Nature Reserve, Tuckean Nature Reserve, Bundjalung National Park, Braemar State Forest, and Nightcap National Park) indicate that the Red Goshawk is utilising these areas.

It is therefore unlikely that the proposed upgrade would further decrease the availability or quality of the potential habitat within the study area to the extent where the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Road corridors are a known vector for invasive species; these are already recorded throughout the study area.Road corridors have the potential to exacerbate existing weed invasions in the impacted patches of vegetation, and increase edge effects. However, vegetation within the study area is moderate to poor quality and already impacted by invasive species and edge effects. As such the proposed upgrade is unlikely to further degrade the potential habitat significantly. In addition, mitigation measures have been proposed to reduce the impact of weed invasion. It is therefore unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Disease has been identified as one of the possible threats and possible reasons for decline of the Red Goshawk in the Recovery Plan for the Red Goshawk (NPWS 2006).

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. However, as the potential habitat for the Red Goshawk in the study area is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species’ decline.

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment and Water Resourses may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act.

The DECC has prepared a Recovery Plan for the Red Goshawk. The aim of this plan relevant to the proposed upgrade is to identify and protect habitat being used by Red Goshawks, especially nesting areas.

The proposed upgrade would result in the clearing of 2.0 ha of potential habitat and edge effects into a further 3.6 ha of potential habitat (Lowland Rainforest). Although clearing of habitat is identified as a threat to the recovery of the Red Goshawk, the proposed area to be cleared is less than 1% of the distribution of potential habitat in the Locality. In addition, potential habitat within the study area is considered to be moderate to poor quality and no nesting sites have been recorded in the study area or the Locality. For these reasons it is unlikely that the proposed upgrade would interfere with the recovery of the Red Goshawk.

Conclusion

Based on the above assessment, the Red Goshawk is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Three-toed Snake-tooth Skink *Coeranoscincucs reticulatus*

The Three-toed Snake-tooth Skink occurs in rainforest and moist layered forest on loamy or sand soils(DEH 2006a). Often found within this habitat in well-mulched loose soil, leaf litter and rooting logs near fallen tree trunks (DEC 2005¤, DEH 2006a).

This species was not recorded within the study area during the current or previous surveys. However, potential habitat occurs within the Lowland Rainforest communities. The proposed upgrade is likely to remove and/ or modify approximately 5.6 ha of this potential habitat including 2.0 ha from direct impacts such as clearing and 3.6 ha indirectly. The main impacts of the proposed upgrade on this species would be clearing of habitat and sedimentation from runoff during construction. It is expected that these potential impacts would be minimised by

proposed mitigation measures.

This species is known to occur between Cooloola in Queensland to just south of Wauchope in NSW.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

If a population of Three-toed Snake-tooth Skink occurs in the study area and adjacent land, it is not considered to be an important population for the following reasons:

- it is unlikely to be a key source population either for breeding or dispersal as the majority of records of this species in NSW appear to be west of the Great Dividing Range and dispersion is limited due to the species low mobility;
- it is unlikely to be necessary for maintaining genetic diversity, as there is no evidence that the study area contains an isolated genetic variant of this species or that the proposed upgrade would impact on the overall genetic diversity of the species; and,
- the study area is not at or near the limit of the species range, which extends from Cooloola in southeastern Queensland to Grafton in northeastern NSW

The proposed upgrade is likely to impact 5.6 ha of potential habitat (2.0 ha due to clearing; 3.6 from indirect impacts) for this species. These habitat types have an extant area of 776 ha (NPWS 1997b) within the Locality. The amount to be removed therefore represents 0.3 % of the extant area of potential habitat in the Locality. No known populations of the Three-toed Snake-tooth Skink would be impacted by the proposed upgrade therefore the proposed upgrade is unlikely to cause a decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

If a population of Three-toed Snake-tooth Skink occurs in the study area it is not considered to be an important population. This species has not been recorded in the study area or within the Locality. The nearest records are from the Night Cap National Park north of the study area.It has also been recorded in the Mebbin Nature Reserve and to the west in the Great Dividing Range (DEC 2007). It is rarely recorded due to its burrowing habits.

The proposed upgrade is likely to remove 2.0 ha of potential habitat for this species. These habitat types have an extant area of 776 ha (NPWS 1997b) within

the Locality. The amount to be removed therefore represents 0.3 % of the extant area of potential habitat in the Locality. In addition, no known populations occur in the study area.Therefore, it is unlikely that the proposed upgrade would reduce the area of occupancy of an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

If a population of Three-toed Snake-tooth Skink occurs in the study area it is not considered to be an important population. Potential habitat for this species is currently fragmented by agriculture, existing development and associated infrastructure. Lowland Rainforest that would be directly impacted as part of the proposed upgrade consists of six small, isolated patches of native vegetation in a predominantly cleared landscape. Only current edges are likely to be impacted by the proposed upgrade. It is not anticipated that the proposed upgrade will exaggerate the existing fragmentation of potential habitat for this species and is unlikely to fragment an existing population of the Three-toed Snake-tooth Skink.

Is the action likely to adversely affect habitat critical to the survival of a species?

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date, no areas of critical habitat have been listed for the Three-toed Snake-tooth Skink.

Is the action likely to disrupt the breeding cycle of an important population?

The Three-toed Snake-tooth Skink has not been previously recorded and was not recorded within the study area during the current surveys. If a population of Three-toed Snake-tooth Skink occurs in the study area it is not considered to be an important population. The proposed upgrade is likely to directly impact approximately 2.0 ha of potential forest habitat for this species, however given the extant of similar habitat within the local area (776 ha (NPWS 1997b)) it is not considered to be significant. If this species does occur within the study area, it is unlikely that the proposed upgrade would disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed upgrade is likely to remove and/ or modify approximately 5.6 ha of this potential habitat including 2.0 ha from direct impacts such as clearing and 3.6

ha indirectly. However, vegetation within the study area is of moderate to poor quality and already impacted by edge effects. As such the proposed upgrade is unlikely to further decrease the availability or quality of the potential habitat within the study area to the extent where the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Road corridors are known vectors for invasive species; these are already recorded throughout the study area.The proposed upgrade may exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures such as bush regeneration and using locally native species in landscaping the impacts of weed invasion may be reduced. It is therefore unlikely that the proposed upgrade would result in a significant increase in harmful invasive species becoming established in potential habitat within the study area .

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Diseases have not been identified as a threat to populations of the Three-toed Snake-tooth Skink (NPWS 2001d).

Road corridors have the potential to introduce or increase incidence of external diseases into vegetation or populations. However, as the potential habitat for the Three-toed Snake-tooth Skink in the study area is already degraded and fragmented by existing roads and agricultural uses, it is unlikely that the proposed upgrade would introduce new diseases into the area which could result in the species' decline.

Is the action likely to interfere substantially with the recovery of the species?

The Australian Government Minister for the Environment, Water, Heritage and the Arts may make or adopt and implement Recovery Plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act.

No Recovery Plan has been prepared for the Three-toed Snake-toothed Skink to date. The DECC has compiled a list of priority actions to aid in the recovery of the species. Those actions relevant to the proposed upgrade are listed below:

- Prevent clearing of woodland and forest habitats where the species is known to occur; and,

- Do not stock-pile or burn logging waste in forest or woodland where the species occurs.

The proposed upgrade would result in the clearing of 2.0 ha of potential habitat and edge effects into a further 3.6 ha of potential habitat (Lowland Rainforest). Although clearing of habitat is identified as a threat to the recovery of the Three-toed Snake-toothed Skink, the proposed area to be cleared is less than 1% of the distribution of potential habitat in the Locality. In addition, potential habitat within the study area is considered to be moderate to poor quality and the species has not been recorded in the study area or the Locality. For these reasons it is unlikely that the proposed upgrade would interfere with the recovery of the Three-toed Snake-toothed Skink.

Conclusion

Based on the above assessment, the Three-toed Snake-tooth Skink is unlikely to be significantly impacted by the proposed upgrade, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Migratory Animal Species

Sixteen migratory species or their habitat have been previously recorded in the local area of the proposed upgrade (Appendix 6). Of these, 13 species are considered to have potential habitat within the study area and have been considered under the guidelines for significance for the EPBC Act (Table 12).

Table 12: Migratory species with potential habitat within the Subject Site

Scientific Name	Common Name	Significance impact question			Significant Impact
		1	2	3	
Erythrotriorchis radiatus	Red Goshawk	7	7	7	No
Haliaeetus leucogaster	White-bellied Sea-eagle	7	7	7	No
Stictonetta naevosa	Freckled Duck	7	7	7	No
Hirundapus caudacutus	White-throated Needletail	7	7	7	No
Monarcha melanopsis	Black-faced Monarch	7	7	7	No
Monarcha trivirgatus	Spectacled Monarch	7	7	7	No
Myiagra cyanoleuca	Satin Flycatcher	7	7	7	No
Rhipidura rufifrons	Rufous Fantail	7	7	7	No
Grus rubicunda	Brolga	7	7	7	No
Gallinago hardwickii	Latham's Snipe	7	7	7	No
Rostratula benghalensis	Australian Painted Snipe	7	7	7	No

Scientific Name	Common Name	Significance impact question			Significant Impact
		1	2	3	
Ardea ibis	Cattle Egret	7	7	7	No
Lophoictinia isura	Square-tailed Kite	7	7	7	No

7= a negative response to the questions, No = no significant impact

For the purposes of the EPBC Act, an area of important habitat for migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
- habitat utilised by a migratory species which is at the limit of the species range, or
- habitat within an area where the species is declining.

None of the species to be considered are at the edge of their range, the study area does not constitute an area containing a significant proportion of the population and the species are not considered to be declining in the study area.Thus none of the 13 species require consideration under criteria 1 and 2.

Is the action likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species?

Potential habitat within the study area is not considered to be an area of important habitat for these 13 migratory species. Furthermore, the proposed upgrade is likely to directly impact 2.0 ha of potential habitat for these species within the study area, with a further 3.6 ha from indirect impacts. This represents less than 1% of similar habitat available in the Locality. Given the small amount of potential habitat to be removed and /or modified and the mobility of these species it is unlikely that the proposed upgrade would substantially modify, destroy or isolate an area of potential habitat within the study area .

Potential habitat for migratory species (such as the White-bellied Sea-eagle and Freckled Duck) dependant on waterbodies occurs within the study area in the dams, depressions, creeks and drainage lines. These habitats are likely to be indirectly impacted by the proposed upgrade from erosion and sedimentation.

These habitat features are considered to be well represented in the local area within the SEPP 14 wetlands (Cumbebin Swamp and Ballina Nature Reserve), creeks (Emigrant, Byron and Tinderbox Creeks) and farm dams. Given

the mobility of these species, extant of potential habitat in the local area and with mitigation measures to be implemented during the operation and construction phase, such as sediment controls, it is unlikely that these species would be significantly impacted.

Is the action likely to result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species?

Potential habitat within the study area is not considered to be an area of important habitat for these 13 migratory species.

Is the action likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species?

The proposed upgrade is likely to directly impact 2.0 ha of potential habitat for these species within the study area with a further 3.6 ha from indirect impacts, which represents less than 1% of that available in the Locality.

In addition, potential habitat for migratory species (such as the White-bellied Sea-eagle and Freckled Duck) dependant on waterbodies may be indirectly impacted by the proposed upgrade from erosion and sedimentation. These habitat features are considered to be well represented in the local area within the SEPP 14 wetlands (Cumbebin Swamp and Ballina Nature Reserve), creeks (Emigrant, Byron and Tinderbox Creeks) and farm dams. Given the mobility of these species, extant of potential habitat in the local area and with mitigation measures to be implemented during the operation and construction phase, such as sediment controls, it is unlikely that these species would be significantly impacted.

Although the 13 migratory species may use the resources within the study area, it is unlikely that the direct impacts on the potential habitat would disrupt the lifecycle of an ecologically significant proportion of the population of any of these migratory species.

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