Appendix B

Supplementary Flora and Fauna Assessment

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Roads and Traffic Authority

Pacific Highway Upgrade - Oxley Highway to Kempsey

Supplementary Flora and Fauna Assessment

February 2011

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Abbreviations

Term	Definition
CRAFTI	Regional forest ecosystem mapping undertaken by the former National Parks and Wildlife Service as part of the regional forest agreement process
DECC	Former Department of Environment and Climate Change (NSW) *now Department of Environment, Climate Change and Water*
DECCW	Department of Environment, Climate Change and Water (NSW) *formerly Department of Environment and Climate Change (DECC)*
DEWHA	Former Department of the Environment, Water, Heritage and the Arts (Commonwealth)
DNR	Former Department of Natural Resources (NSW), now part of the NSW Department of Water and Energy (DWE)
DP	Deposited Plan
DPI	Former Department of Primary Industries (NSW) *now Department of Industry and Investment (NSW)*
DII	Department of Industry and Investment (NSW) *formerly Department of Primary Industries (DPI)*
EEC	Endangered ecological community
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*
NPWS	Former National Parks and Wildlife Service *now Department of Environment, Climate Change and Water*
NSW	New South Wales
NTU	Nephelometric turbidity units
pH	Measure of acidity
RTA	Roads and Traffic Authority of NSW
SEPP	State Environmental Planning Policy
SEWPAC	Department of Sustainability, Environment, Water, Population and Community (Commonwealth) *formerly Department of the Environment, Water, Heritage and the Arts*
TSC Act	*Threatened Species Conservation Act 1995*

Executive summary

GHD was engaged by the RTA to undertake ecological assessments for five additional areas (the study area) that will be affected by the Pacific Highway upgrade between the Oxley Highway and Kempsey (the Proposal). These areas were not previously subject to an ecological survey as part of the original Environmental Assessment (GHD 2010b) for the Proposal. These sites are referred to as:

- Lot 80 DP 737375 (property either side of Stumpy Creek).
- Ravenswood Road (service road).
- Rodeo Drive (service road).
- Cooperabung Road (service road).
- Lot 1 DP 624217(Wilson River floodplain).

Methodology

Additional field surveys were undertaken from 25 to 29 October 2010 to investigate the ecological values of the study area. Surveys involved the use of systematic flora and fauna sampling techniques in accordance with *Draft Threatened Biodiversity Survey and Assessment Guidelines* (DECC 2004) and prior survey methods. The survey design took into consideration the linear nature of the Proposal (eg greater proportion of flora transects versus flora quadrats) and the potential biological variability of the study area (ie stratification).

Results

The field surveys identified the flora and fauna values of the study area as being largely consistent with prior investigations reported in the Flora and Fauna Working Paper (GHD 2010a) and Environmental Assessment (GHD 2010b). The main findings of the surveys within the study area are the confirmation of previously reported ecological values such as:

- The absence of threatened flora and aquatic species.
- The presence of threatened fauna species habitat including the grey-headed flying fox (*Pteropus poliocephalus*) and numerous threatened microchiropteran bat species such as the little bent-wing bat (*Miniopterus australis*), large bent-wing bat (*Miniopertus shreibersii*), eastern freetail bat (*Mormopterus norfolkensis*), greater broad-nosed bat (*Scotaenax ruppellii*) and eastern false pipistrelle (*Falsistrellis tasmaniensis*). A new record of the hoary wattled bat (*Chalinolobus nigrogriseus*) is additional to previous survey findings.
- The presence of various coastal floodplain endangered ecological communities (EEC).

The spatial distribution of these ecological values is consistent with those identified in prior studies (GHD 2010a; GHD 2010b).

Conclusions

The Proposal would result in impacts on native biota and their habitats through the clearing of 5.8 hectares of native vegetation. This vegetation also includes 3.8 hectares of vegetation consistent with the following TSC Act listed EECs:

- Swamp Sclerophyll Forest (1.7 hectares).
- Swamp Oak Floodplain Forest (0.8 hectares).
- Subtropical Coastal Floodplain Forest (1.2 hectares).
- Freshwater Wetlands (0.1 hectares).

The majority of these impacts have been previously identified in the Environmental Assessment (GHD 2010b) and Flora and Fauna Working paper (GHD 2010a) and are predominantly consistent with the estimates provided in these assessments. However some additional impacts have been identified within the study area with the key differences between the study area and the remainder of the Proposal identified as follows:

- An increase of 0.4 hectares of dry ridgetop forest vegetation clearing at Stumpy Creek.
- Net increased clearing of Subtropical Coastal Floodplain Forest (0.8 hectares).
- Loss of foraging habitat for the hoary wattle bat at Stumpy Creek

The direct removal of this vegetation is not likely to comprise a significant reduction in the extent of these EECs and habitat for any local populations of native. On this basis it is considered that the Proposal continues to meet the 'maintain and improve test' under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) when considered within the context of the proposed mitigation measures identified in the Environmental Assessment (GHD 2010b), Flroa and Fauna Working paper (GHD 2010a) and this report (ie no net biodiversity losses eventuate as a consequence of the Proposal).

Impact mitigation measures would avoid or reduce the potential for adverse impacts on threatened biota and their habitats at the site. Mitigation measures recommended in this report include:

- Incorporation of mitigation actions identified in the Flora and Fauna Working Paper (GHD 2010a) within a Construction Environmental Management Plan for the Proposal.
- Establishment of an offset strategy to offset residual impacts on native biota.

1. Introduction

In September 2010, GHD prepared a Flora and Fauna Working Paper (Working Paper) that was prepared as a technical document to support the Part 3A Environmental Assessment for the upgrade of the Pacific Highway between the Oxley Highway and Kempsey ('the Proposal') (GHD 2010a, GHD 2010b). The Working Paper documented the results of terrestrial and aquatic ecological assessments that were undertaken for the Proposal, providing details regarding the potential impact of the Proposal and outlined measures to minimise and mitigate these impacts.

GHD was subsequently engaged by the RTA to undertake supplementary ecological assessments for five additional sites that will be affected by the Proposal. These sites were not previously subject to an ecological survey as part of the original Environmental Assessment for the Proposal.

This supplementary report provides information regarding the flora and fauna assessments undertaken for the Proposal at the five additional study sites and addresses terrestrial and aquatic ecology impacts associated with the highway upgrade in these locations. The report also documents any changes in cumulative impacts associated with the Proposal from those stated in the Working Paper (GHD 2010a).

This report should be read in conjunction with all other documents relevant to the Proposal, in particular the Environmental Assessment and Working Paper (GHD 2010a, GHD 2010b).

1.1 Proposal overview

The proposed upgrade of the Pacific Highway between the Oxley Highway and Kempsey is part of the Pacific Highway Upgrade Program, being implemented by the New South Wales (NSW) Roads and Traffic Authority (RTA) and the Australian Government.

The Proposal would commence approximately 700 metres north of the Oxley Highway interchange, tying in with the existing dual carriageways to the south, and continue northwards to tie in at Stumpy Creek with the dual carriageways of the proposed Kempsey to Eungai Pacific Highway upgrade. At the northern end of the Proposal, the eastern service road would extend approximately 320 metres further to the north of Stumpy Creek to tie in with the southern interchange of the proposed Kempsey to Eungai upgrade.

The majority of the Proposal would require duplication of the existing highway. Two main sections of the Proposal would deviate from the alignment of the existing highway. These are in the vicinity of the Hastings River and the Wilson River. The existing highway would be retained wherever possible for use as a service road or local road connection.

A detailed overview of the Proposal can be found in Section 6 of the Environmental Assessment (GHD 2010b).

To date there have been a number of detailed ecological surveys that have been undertaken throughout the route development, preferred route selection and concept design phases for the Proposal.

These include:

- Preliminary Terrestrial Flora and Fauna Assessment – Working Paper (Ecotone Ecological Consultants 2006a).
- Preliminary Terrestrial Flora and Fauna Assessment: Advanced Investigations – Working Paper (Ecotone Ecological Consultants 2006a).
- Preliminary Aquatic Flora and Fauna Assessment Report (HWR Ecological 2005b).
- Aquatic Flora and Fauna Assessment Report – Floodplain Investigation (HWR Ecological 2005a).
- Aquatic Flora and Fauna Assessment Report – Riparian Surveys, Wilson River (HWR Ecological 2006).
- Supplementary Aquatic Flora and Fauna Assessment Report – Refined Orange Option, Section B (HWR Ecological 2006).
- Flora and Fauna Working Paper (GHD 2010a).

The Working Paper provides the results of detailed terrestrial flora and fauna fieldwork and reporting that was undertaken by Ecotone Ecological Consultants for the Proposal. This included detailed ecological assessment along a strip of land 150 metres wide along the length of the Proposal with two wider areas at the southern end of the study area from Fernbank Creek to Cairncross State Forest and further through Cairncross State Forest to Haydons Wharf Road. It also included all roundabouts, on- and off-ramps and interchanges. This study was supported by supplementary terrestrial flora, fauna and aquatic fieldwork and reporting undertaken by GHD for the Proposal.

Due to access issues the prior ecological investigations did not include field surveys of two properties as well as a number of proposed service roads that would be impacted by the Proposal. The purpose of this investigation was to undertake an ecological assessment within these previously unsurveyed areas.

1.2 Regional and local context

The Proposal is situated within the North Coast Bioregion as defined in the Interim Biogeographic Regionalisation of Australia (Thackway and Cresswell 1995). This bioregion follows the east coast of NSW from Raymond Terrace to the Queensland border. Within the North Coast Bioregion, the Proposal is located within the Macleay Hastings Catchment Management Authority sub-region.

The Proposal is located within the Port Macquarie-Hastings and Kempsey local government areas. The location of the Proposal is shown in **Figure 1-1**.

The area through which the Proposal passes contains a number of state forests, nature reserves, and wetlands listed under *State Environmental Planning Policy No. 14 – Coastal* Wetlands, as well as key habitat and wildlife corridors, as mapped by the former Department of Environment and Climate Change (Scotts 2003). Land use within the study locality generally consists of residential, rural, commercial, industrial, state forests, national parks and reserves. Rural land use, state forests and conservation areas are the dominant land uses.

1.3 The study area

The study area for the supplementary assessment includes the following study sites:

- Lot 1 DP 624217 (Site 1). This private property was not previously surveyed due to access restrictions. It is situated within the Proposal footprint and falls within an area where the RTA proposes to construct a new section of highway. Within this property the area of investigation includes a 150 metre wide corridor along the Proposal boundary.
- Road reserves along existing formed sections of Cooperabung Drive (Site 2), Rodeo Drive (Site 3) and Ravenswood Road (Site 4). It is proposed that these existing roads will become part of the service road network for the Proposal. In order to meet the required minimum criteria for service roads specified in the concept design, these local roads would require varying degrees of upgrade.
- Lot 80 DP 737375 (including Stumpy Creek) (Site 5). Within this section of the Proposal, the RTA proposes to construct a new service road to connect Kemps Road from just north of Maria River to the proposed interchange at the southern limit of the Kempsey to Eungai Pacific Highway upgrade project. Design of this service road would also include the construction of a bridge over Stumpy Creek. Within this property the area assessed for the terrestrial ecology surveys refers to a strip of land 150 metres wide along the length of the proposed highway alignment. The area assessed along of Stumpy Creek for aquatic ecology surveys refers to 300 metres downstream within Lot 80 DP 737375 and 100 metres upstream of the existing Pacific Highway[1].

Figure 1-2 identifies the location of these study sites.

1.4 Legislative context

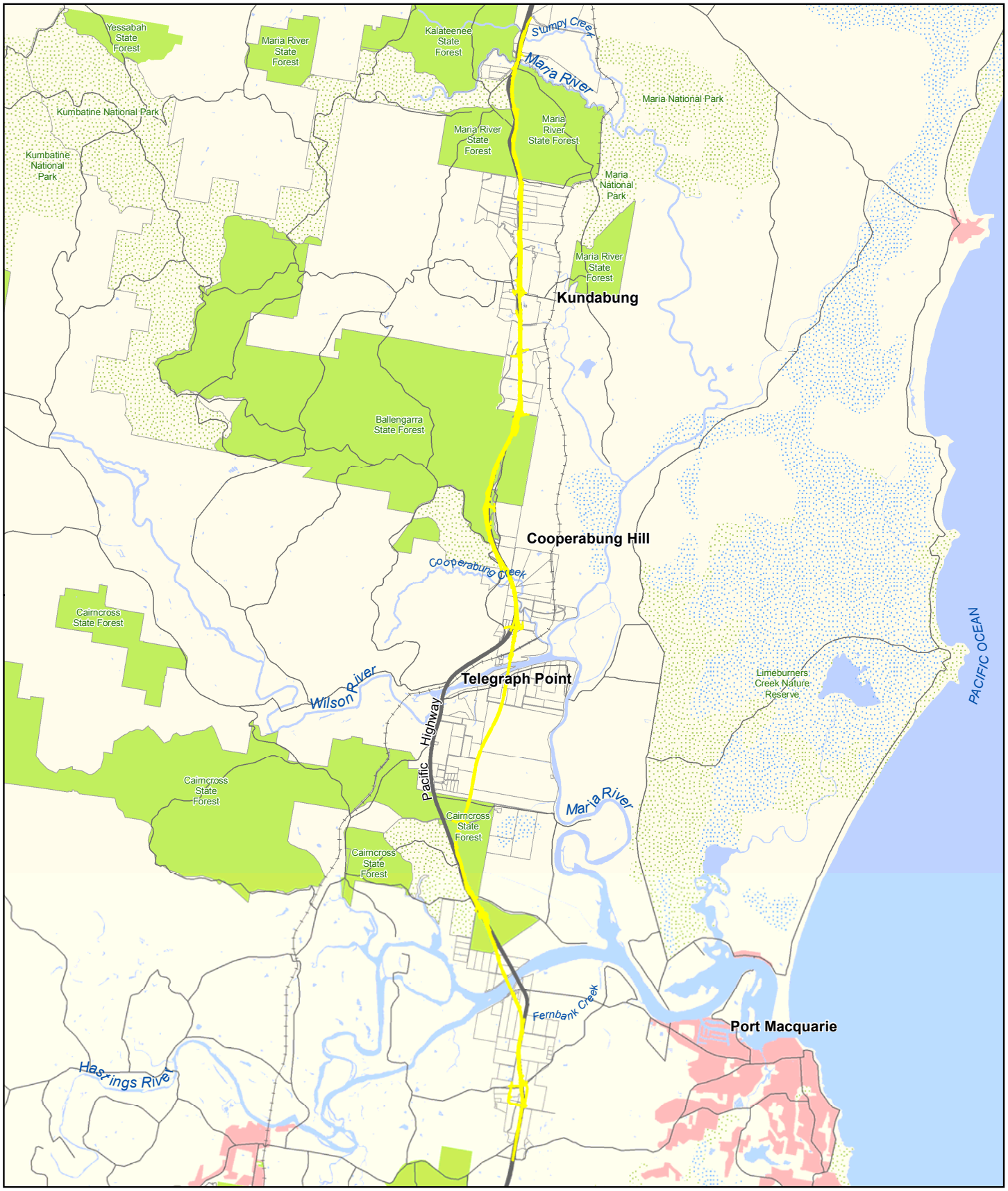
A detailed account of the legislative context is provided in the Working Paper (GHD 2010a). A summary is provided in the following sections.

1.4.1 State legislation

The assessment presented in this report is consistent with the framework outlined in the Working Paper (GHD 2010a). Relevant legislation identified in the Working Paper that has been considered in this report is as follows:

- Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).
- Part 3 and Schedules 1, 1A, 2 and 3 of the NSW *Threatened Species Conservation Act 1995* (TSC Act).
- Schedule 4 and 4A of the NSW *Fisheries Management Act 1994* (FM Act).
- NSW *National Parks and Wildlife Act 1974*.
- NSW *Noxious Weeds Act 1993*.
- *State Environmental Planning Policy No. 14 – Coastal Wetlands* (SEPP 14), *State Environmental Planning Policy No. 26 – Littoral Rainforests* (SEPP 26), *State Environmental Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) and *State Environmental Planning Policy No. 71 – Coastal Protection* (SEPP 71).

[1] Note that this upstream section of Stumpy Creek occurs within Lot 1 DP 399379



LEGEND

Roads	Bulit-up urban areas	Watercourse	Existing highway
Railway	National parks, Nature reserves	Wetlands	Proposal
Cadastre	State forests	Ocean	

1:170,000(at A4)

0 750 1,500 3,000 4,500 6,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 11 NOV 2010

Location of the Proposal

Figure 1.1

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com.au W www.ghd.com.au

C:\GIS\1205704\Additional Field Survey Maps\OHK_AFS_001_ProposalLocation_20101110_A_V93.mxd

Data Source: Geosciences Australia: Topography - 2007; GHD: Field Survey Data - 2010; Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton

LEGEND

- Study Area
- Cadastre
- Concept Design

1:110,000 (at A4)

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 11 NOV 2010

Study Area

Figure 1.2

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

C:\GIS\1205704\Additional Field Survey Maps\OHK_AFS_002_StudyArea_20101110_A_V93.mxd

Data Source: Geosciences Australia: Topography - 2007; GHD: Field Survey Data - 2010; Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton

Threatened species, endangered populations, endangered ecological communities (EECs) and critical habitat have been assessed in accordance with the Draft Threatened Species Part 3A Assessment Guidelines prepared by the Department of Environment and Conservation and the Department of Primary Industries (DEC/DPI 2005).

No mapped occurrences of SEPP 14 Wetlands or SEPP 26 Littoral Rainforests are coincident with the study area although there are SEPP 14 Wetlands located within 1 km to the north of the study area at the Wilson River. Areas qualifying as potential koala habitat under SEPP 44 have been identified within the study area and have been further considered within this report. SEPP 71 has been considered as the study area is within 2 kilometres of the Wilson River.

1.4.2 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) establishes a requirement for Commonwealth environmental assessment and approval for actions that are likely to have a significant impact on matters of national environment significance, the environment on Commonwealth land or actions taken on Commonwealth land.

The EPBC Act identifies eight matters of national environmental significance:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Great barrier reef marine park.
- Nuclear actions (including uranium mining).

This report in conjunction with the Working Paper addresses the matters of environmental significance that are relevant to the Proposal.

1.5 Objective of this report

The objective of this report is to provide an ecological impact assessment of the Proposal on a number of areas not previously investigated in the Environmental Assessment. The report will also identify any additional ecological impacts and associated management measures relevant to those areas. The assessment is to be consistent with Part 3A of the EP&A Act.

1.6 Scope of this report

The specific aims of this assessment are to:

- Undertake an ecological assessment for a number of areas that were not included in the Working Paper for the Proposal.
- Identify and describe attributes of the existing environment in these additional areas, including type and condition of vegetation communities and habitats.

- Determine the occurrence or likelihood of occurrence of threatened species, populations ecological communities and their habitats listed under the TSC Act, FM Act and EPBC Act within the study area.
- Assess the significance of any additional impacts on the above in accordance with Part 3A of the EP&A Act and EPBC Act threatened species assessment requirements.
- Identify measures to avoid, minimise, mitigate and offset impacts on biodiversity values within the additional study areas.

1.7 Report structure

The structure and content of this report is as follows:

- Chapter 1 – Introduction. Describes background to proposal, study area, Proposal overview, legislative context and scope.
- Chapter 2 – Methods. Details the desktop review, terrestrial and aquatic field survey and assessment methods.
- Chapter 3 – Description of the existing environment. Describes the existing environment within the additional study areas, including vegetation communities, terrestrial flora and fauna, terrestrial and aquatic habitats and aquatic fauna.
- Chapter 4 – Impacts on biodiversity. Describes the potential additional impacts of the Proposal on biodiversity, including loss and disturbance of vegetation and habitats and impacts on threatened species and ecological communities.
- Chapter 5 – Management and mitigation. Describes measures implemented to avoid, minimise, mitigate and offset impacts on biodiversity values.
- Chapter 6 – Conclusions. Summarises the key findings and addresses key thresholds pursuant to DEC/DPI (2005) Part 3A threatened species assessment guidelines with respect to the additional areas surveyed during this assessment.
- Chapter 7 – References.

2. Methods

The field surveys and assessment undertaken for the study area were designed to build on the information obtained throughout the route development, preferred route selection, concept design and environmental assessment phases for the Proposal.

The assessment included updated literature reviews and both terrestrial and aquatic flora and fauna field surveys. Field survey techniques and survey effort were in accordance with the Department of Environment and Climate Change's *Draft Threatened Biodiversity Survey and Assessment Guidelines* (DECC 2004).

2.1 Definitions of relevant areas

For the purposes of this report the following areas are defined:

- The 'study locality' is the area within 10 kilometres of the centreline of the Proposal.
- The 'additional study area' consisting of five separate 'study sites' that were surveyed as part of this assessment. 'Study sites' included:
  - Site 1 - Lot 2 DP 621797, a private property that was not previously surveyed due to access restrictions. Within this property the area of additional investigation refers to a strip of land 150 metres wide along the length of the proposed highway alignment.
  - Site 2 - The existing road reserve along either side of Cooperabung Drive.
  - Site 3 - The existing road reserve along either side of Rodeo Drive.
  - Site 4 - The existing road reserve along either side of Ravenswood Road.
  - Site 5 - Lot 80 DP 737375, this property includes the Stumpy Creek northern extension. Within this property the area of additional investigation for terrestrial ecology surveys refers to a strip of land 150 metres wide along the length of the proposed highway alignment. The area of additional investigation within Stumpy Creek for aquatic ecology surveys refers to 300 metres downstream within Lot 80 DP 737375 and 100 metres upstream of the Pacific Highway within Lot 1 DP 399379.
- The 'Proposal boundary' refers to the area of land that would be acquired for the Proposal.
- The 'Proposal footprint' refers to the areas within each 'additional study area' where direct impacts would be likely to occur.

2.2 Literature review

2.2.1 Database searches

A review of available data was undertaken to determine those rare and threatened flora and fauna species, both terrestrial and aquatic, and EECs known or likely to occur within the additional study areas. The initial ecological impact assessment included a data review including the following:

- The SEWPAC website-based EPBC Act Protected Matters Search Tool (as at November 2010).

- The NSW Department of Environment, Climate Change and Water (DECCW) Atlas of NSW Wildlife database (as at November 2010) for the Kempsey (9435-1N), Kundabung (9438-1S) and Telegraph Point (9435-2N) 1:25,000 map sheets.
- The National Herbarium of NSW PlantNet database for threatened and other significant species.
- Forests NSW database.
- The former NSW Fisheries threatened species profiles which describes threatened and protected aquatic species and ecological communities listed on the FM Act.
- NSW Bionet database for threatened terrestrial and aquatic flora and fauna.
- The Australian Museum FaunaNet database for threatened and protected aquatic species.
- *The New Atlas of Australian Birds* (Barrett et al. 2003).

Information obtained from the SEWPAC and Wildlife Atlas database searches was revised in this assessment to ensure currency. These searches resulted in the identification of additional threatened species for consideration. Threatened flora and fauna records from the NSW Wildlife Atlas database are mapped in **Appendix A**. Results for the EPBC Protected Matters Search Tool are included in **Appendix B**.

2.3 Threatened species analysis

2.3.1 Identification of subject species for assessment

The threatened flora and fauna species lists for the locality compiled from the database searches and literature review were refined to include those rare and threatened flora and fauna previously recorded or likely to occur within the additional study areas, based on habitat suitability and distribution ranges. Fauna recorded within the study locality that were excluded from assessment on the basis of clearly unsuitable habitat within the study area included ocean going seabirds, shorebirds, whales, marine turtles and the dugong. All terrestrial threatened fauna species known to occur in the NSW North Coast Bioregion were considered however some species, for example the brush-tailed rock-wallaby, were discarded as the habitat within the study area is unsuitable. The resultant final list of species was then used to guide the techniques applied in the targeted field surveys.

2.3.2 Identification of matters of national environmental significance

The SEWPAC website-based EPBC Act Protected Matters Search Tool was reviewed (as at November 2010) to identify any matters of national environmental significance of relevance to the additional study areas. The EPBC Act Protected Matters search report is provided in **Appendix B**. The likelihood of identified threatened and migratory species occurring in the study area was assessed based on habitat suitability and distribution ranges (see **Appendix F**).

2.4 Field investigations

Following the literature review, field investigations were undertaken within the additional study area to assess the potential impacts of the Proposal on threatened species, populations and endangered ecological communities and their habitats and to assist in identifying the most appropriate impact mitigation and environmental management measures to avoid or minimise the potential for significant adverse impacts.

The survey techniques undertaken to assess the additional study area are described below and summarised in **Table 2-1**. A detailed description of survey techniques is provided in **Appendix C** and survey sites are indicated in **Figure 2-1** to **Figure 2-3**.

Table 2-1 Field surveys conducted to assess potential impacts of the Proposal

Survey type	Survey area	Dates	Survey techniques
Terrestrial flora and fauna survey	Lot 2 DP 621797	28 October 2010	Vegetation quadrats Vegetation mapping Habitat assessment Call playback
Terrestrial flora and fauna survey	Lot 80 DP 737375 (area to north and south of Stumpy Creek)	25-28 October 2010	Vegetation quadrats Habitat assessment Elliot A and B trapping Koala scat searches Reptile searches Anabat and harp trapping Spotlighting Call playback
Aquatic survey	Stumpy Creek - 300 metres downstream and 100 metres upstream from Pacific Highway	3 – 4 November 2010	Habitat assessment Bait traps Fyke nets
Terrestrial flora and survey	Road reserve either side of Cooperabung Drive	28-29 October 2010	Vegetation transects Habitat assessment Koala scat searches Reptile searches Anabat analysis Spotlighting Call playback
Terrestrial flora and survey	Road reserve either side of Rodeo Drive	28-29 October 2010	Vegetation transects Habitat assessment Koala scat searches Reptile searches Anabat analysis Spotlighting Call playback
Terrestrial flora and survey	Road reserves either side of Ravenswood Road	28-29 October 2010	Vegetation transects Habitat assessment Koala scat searches Reptile searches Anabat analysis Spotlighting Call playback

A summary of the overall survey effort is provided in **Section 2.5**.

2.4.1 Terrestrial flora surveys

Comprehensive flora field surveys were undertaken within each of the additional study areas between 25 and 29 October 2010.

Flora survey techniques

A number of techniques were used during terrestrial flora surveys within the additional study areas to target threatened flora species and to verify vegetation communities, in particular EECs. Full descriptions of methods used are provided in **Appendix C**. Quadrat and transect locations are illustrated in **Figure 2-1**.

Flora survey methodologies used included:

- Transects.
- Quadrats: 20 metres x 20 metres.
- GPS recording of vegetation community boundaries.
- EEC mapping and verification.
- Targeted rare or threatened flora species surveys.
- Photographing sites and vegetation communities.

Survey effort

A total of six 20 metre x 20 metre flora quadrats were surveyed during the survey. The location of field survey quadrats were captured with a Trimble hand held GPS unit and are shown in **Figure 2-1**. All species present within each quadrat were recorded with any specimens thought to be threatened species or for which identification was problematic sent to the Herbarium at the Royal Botanic Gardens for verification. Notes were also taken on species dominance, soil type and condition, level of weed invasion and any other signs of disturbance (eg clearing, fire, rubbish dumping, and access disturbance).

A list of all flora species recorded during the surveys is presented in **Appendix D**.

The ecological communities were mapped and an assessment made of the contribution of vegetation within the study area to vegetation links or ‘corridors’ in the locality and region. The structure and floristics of vegetation communities were compared to those ecological communities listed under the TSC Act and EPBC Act to determine if they were characteristic of a threatened ecological community.

2.4.2 Terrestrial fauna surveys

Fauna field surveys to determine the fauna and habitat values within the study area were undertaken in conjunction with the flora assessments between 25 and 29 October 2010.

The timing of the field surveys was chosen to coincide with spring in order to maximise the potential for predicted threatened species to be encountered. For instance, spring is the best time for the detection of most frog, reptile and bat species as activity and breeding is on the increase.

The survey was primarily focused on habitat assessment (including assessment of habitat value in a local and regional context) as well as targeting threatened fauna. During this survey, 11 types of survey method were employed to detect the various types of vertebrate fauna considered likely to occur within the study area.

Fauna survey techniques used included:

- Habitat assessment, including tree hollow counts and 'potential koala habitat' assessments.
- Arboreal and terrestrial live trapping transects using Elliot 'A' and 'B' traps.
- Diurnal bird census, involving observation and call identification.
- Koala scat searches under food trees.
- Nocturnal mammal, bird and frog call playback.
- Spotlighting (walked transects).
- Diurnal reptile searches in areas of suitable habitat.
- Nocturnal frog searches in areas of suitable habitat.
- Ultrasonic bat call detection.
- Harp trapping for bats along potential flyways.

All observations were recorded on pro forma field data sheets. A list of all fauna species recorded during the surveys can be found in **Appendix E**.

Survey site selection

The broad stratification units determined for flora survey work were refined as a basis for determining fauna survey sites within the study area. Survey sites were chosen so as to provide the best possible sampling of each fauna habitat type within the study area. The locations of survey sites are shown in **Figure 2-1** and **Figure 2-2**.

Fauna survey techniques

A variety of techniques were used during fauna surveys within the additional study area to target threatened fauna species. Detailed descriptions of survey techniques are outlined below.

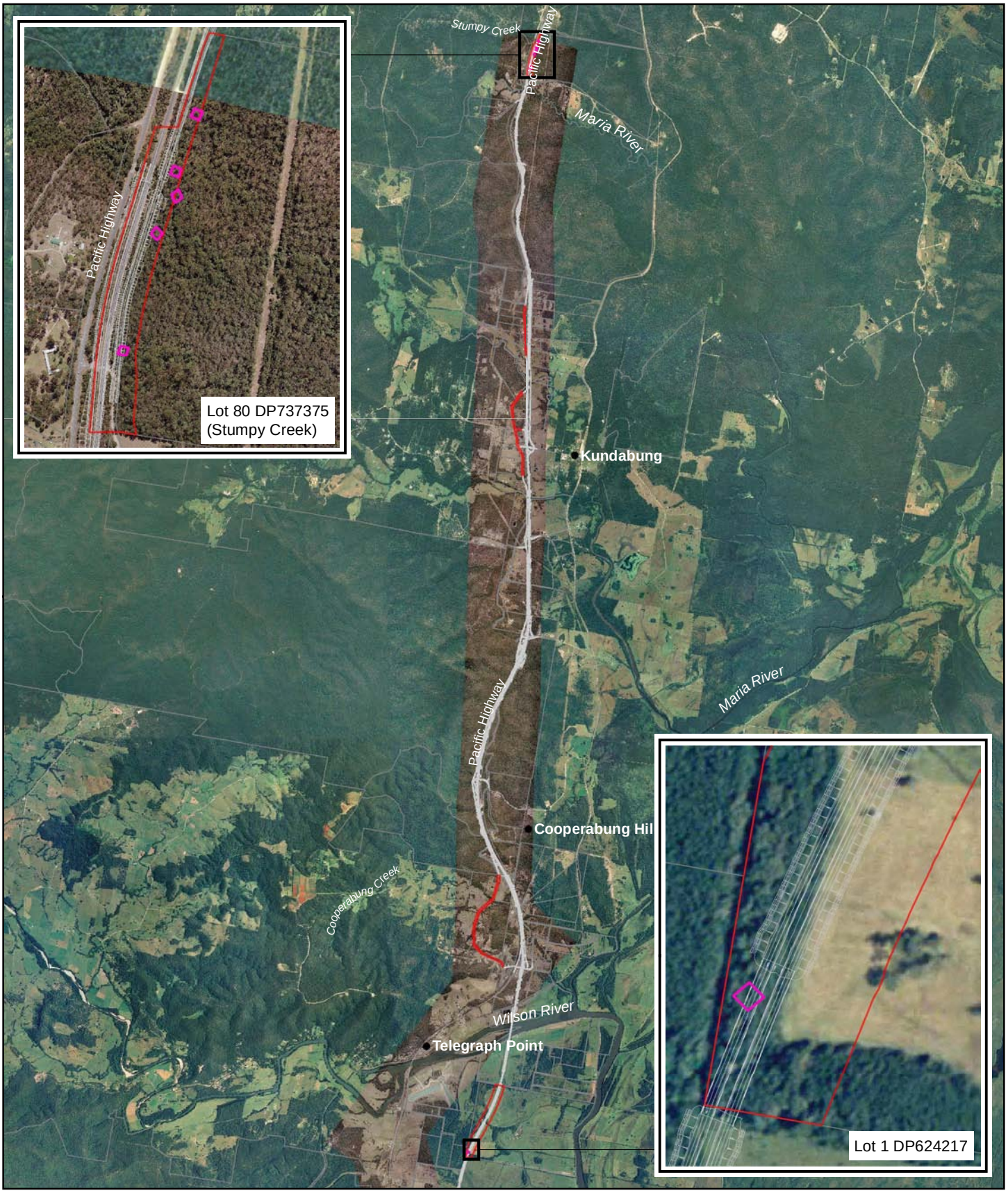
Trapping for arboreal and ground-dwelling mammals

Trapping for arboreal and ground-dwelling mammals was undertaken in Site 1 - Lot 80 DP 737375 in order to determine which species of mammals may occur within the study area, in particular threatened species that were identified in the desktop assessment as having the potential to occur within the vicinity of the study area. These species included the New Holland mouse (*Pseudomys novaehollandiae*), squirrel glider (*Petaurus norfolkensis*) and brush-tailed phascogale (*Phascogale tapoatafa*).

Trapping was not undertaken along any of the service roads as there was insufficient habitat availability for target species to appropriately sample for these species. Similarly, habitat within Lot 1 DP 624217 was not amenable to trapping given the absence of hollow bearing trees, simplification of the understorey through grazing/clearing and shape of the vegetation remnant examined (narrow remnant subject to edge effects).

Larger, more difficult species to capture such as the spotted-tailed quoll (*Dasyurus maculatus maculatus*) and long-nosed potoroo (*Potorous tridactylus tridactylis*) were not specifically targeted in the trapping program and have been assessed using habitat and wildlife records.

Two arboreal trap lines (Elliott B) and two ground transects (Elliott A) were established within the property, one either side of Stumpy Creek.



LEGEND

- Study Area
- Cadastre
- Concept Design
- 20 x 20 metre Quadrat

1:110,000 (at A4)

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Additional Field Survey

Job Number 22-1374532
Revision A
Date 25 FEB 2011

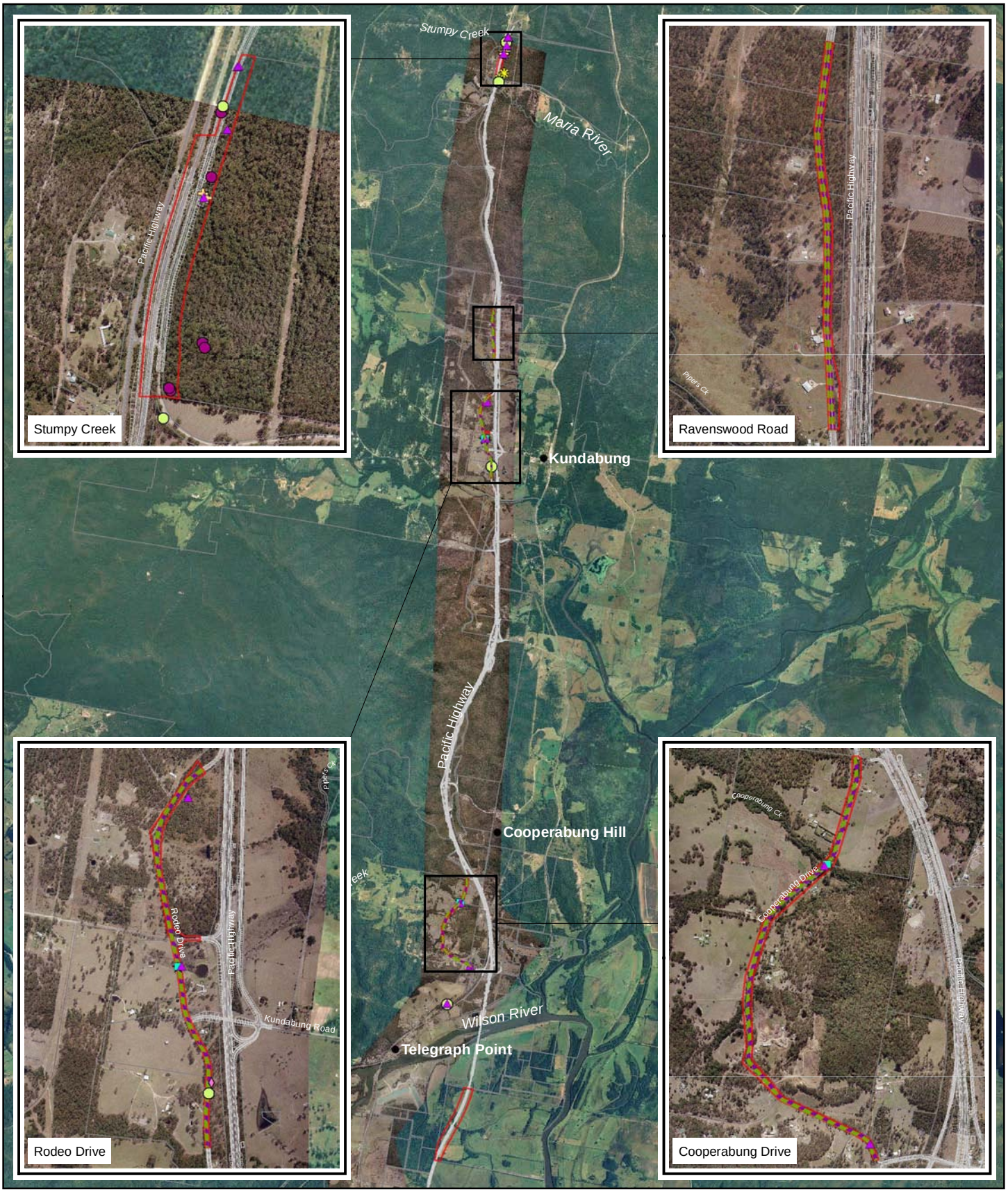
Flora Survey Site Locations

Figure 2.1

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_010_FloraSurveyLocations_20101110_A_V93.mxd

Data Source: Geosciences Australia: Topography - 2007; GHD: Field Survey Data - 2010; Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton



LEGEND

- Study Area
- Cadastre
- Concept Design
- Anabat
- Bird Survey
- Call Playback Sites
- Frog Survey
- Harp Trap
- Koala Spot Assessment Test (KSAT)
- Elliot Trapline
- Flora Transect
- Fauna Transect
- Spotlighting

1:110,000 (at A4)

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 25 FEB 2011

Fauna Survey Site Locations

Figure 2.2

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_011_FaunaSurveyLocations_20101110_A_V93.mxd

Data Source: Geosciences Australia: Topography - 2007; GHD: Field Survey Data - 2010; Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton

All traps were opened and set on 25 October 2010. Every trap was checked each morning, closed and then reopened in the afternoon for three consecutive days. All traps were collected on the morning of 28 October 2010. The total trapping effort amounted to 210 trap-nights.

Elliot traps (size A)

Two ground transects of Elliott traps (size A) were set out, consisting of 25 traps separated by intervals of approximately 5 metres. Traps were baited with a small ball of standard mammal bait (rolled oats, peanut butter and honey). Elliott A traps were used in an effort to detect small ground-dwelling mammals such as the New Holland mouse.

Total Elliot A trap-nights: 25 traps x 2 sites x 3 nights = 150 trap-nights.

Elliot traps (size B)

Two transects of Elliott traps (size B) were fixed to the trunks of trees approximately 2 metres above ground height. Each line consisted of 10 traps separated by intervals of approximately 10 metres. Each trap was baited with a small ball of standard mammal bait (rolled oats, peanut butter and honey) and the trunk above the trap sprayed with honey water. Elliott B traps were used in an effort to target squirrel gliders and brush-tailed phascogales.

Total Elliot B trap-nights: 10 traps x 2 sites x 3 nights = 60 trap-nights.

Diurnal bird surveys

Targeted surveys for diurnal birds were undertaken at all five sites with emphasis on those habitats of potential relevance for threatened species. All dedicated surveys for birds were carried out at either dawn to two hours after sunrise or two hours before dusk to sun down. Standardised 20 minute surveys took the form of one or more of the following:

- Point surveys.
- Walked transects in linear habitats.

Birds were identified by observation with binoculars and/or call identification. Diurnal bird surveys also included searches for habitat features of relevance for particular threatened species, including searching for evidence of feeding (eg *Allocasuarina* chewed cones, signs of glossy black-cockatoo (*Calyptorhynchus lathami*) foraging) and signs of bird presence, such as pellets, whitewash, nests etc.

All bird-survey observations were accompanied by incidental observations of bird species that were noted during the survey. Surveys coincided with flora survey quadrats where appropriate.

Reptile searches

Active searches for reptiles were conducted at all five sites. Shelter sites were carefully lifted and replaced, trunks and decorticating bark were scanned, leaf litter was raked, and visual scanning of vegetation for active and foraging specimens was undertaken. All targeted search efforts for reptiles were made at a time of day that was suitable for reptile activity (warm sunny conditions during the middle part of the day).

Survey techniques employed included:

- Diurnal searches for sheltering reptiles.
- Rock, log and debris rolling.
- Active shelter searches.
- Spotlight surveys for nocturnally active species (eg giant barred frog).

Frog surveys

Targeted surveys for frogs were conducted at locations that were considered likely to provide suitable habitat. This included creek crossings (Stumpy Creek and Cooperabung Creek), farm dams within Site 5 - Lot 1 DP 624217, and any other water ways that occurred within any of the study areas. Search efforts were weighted towards detecting threatened species that may occur in the area (green and gold bell frog (*Litoria aurea)*, green-thighed frog (*Litoria brevipalmata*), stuttering frog (*Mixophyes balbus*) and southern barred frog (*Mixophyes iteratus*)), but all species were considered. Surveys at smaller creek crossings, ponds and drainage lines involved listening only. Other surveys of larger water bodies involved listening for calls and active searching with spotlights, as described above.

In addition to active searches for frogs, call-playback for green and gold bell frog and was attempted at a number of locations. Call-playback is considered separately (below).

Microchiropteran bat survey

Stationary Anabat recordings were undertaken for one to two nights at each of the five sites (**Figure 2-2**). Recordings commenced approximately half an hour before dusk and continued until the following morning.

Calls collected during the field survey were identified using zero-crossing analysis and AnalookW software (version 3.6g, Chris Corben 2009) by visually comparing call traits. The analysis of all bat calls was undertaken by GHD ecologist Mark Aitkens. The *Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay *et al*. 2004) was used as a guide to call analysis. Due to the high level of variability and overlap in call characteristics, a conservative approach was taken when analysing calls.

One large harp trap was also set up for three nights at Lot 80 DP 737375. This trap was placed within a vegetation corridor on the edge of Stumpy Creek. The trap was checked twice each day, towards the conclusion of nocturnal surveys (9pm to 10pm) and just before dawn (5.30am to 6am).

Spotlighting

Mammals and nocturnal birds were identified by observation under spotlight or by vocalisations heard whilst spotlighting.

Within Lot 80 DP 737375, spotlight searches were undertaken along transects on foot for nocturnally active animals (mammals, birds and herpetofauna), including dedicated listening periods for fauna vocalisations, in areas of appropriate habitat in the study area. For each of the three service roads assessed, spotlighting was undertaken from the car whilst driving at a fast walking pace. The full section of road reserve was surveyed along each of these roads. No spotlighting was undertaken at Lot 1 DP 624217 as it was determined that there was not suitable habitat for threatened nocturnal mammals within this property.

Call playback

Call playback was used in an effort to invoke acoustic or behavioural responses from relatively vocal fauna such as nocturnal birds and frogs. Call playback surveys were conducted at all sites except Lot 1 DP 624217 over three consecutive nights. Calls used included the powerful owl (*Ninox strenua*), squirrel glider (*Petaurus norfolcensis*), koala (*Phascolarctos cinereus*), green and gold bell frog (*Litoria aurea*) barking owl (*Ninox connivens*) and masked owl (*Tyto novaehollandiae).* Surveys involved an initial listening period of five minutes followed by call playing for five minutes followed by a listening period of five minutes (undertaken separately for each species). Potential

roost sites in the immediate area were then scanned using spotlights. Calls were played through a portable MP3 player connected to a 15W megaphone.

Call playback was generally undertaken before or after spotlighting or frogging, but was occasionally completed on its own.

Koala spot assessments

Koala spot assessments were conducted in two locations in the study area where there were an abundance of koala feed trees (Rodeo Drive and Ravenswood Road). These followed the technique of Phillips and Callaghan (1995), and involved undertaking a search for koala faecal pellets beneath 30 koala feed trees at each location. The search included scanning the tree for koalas, looking for scratch marks on tree trunks, cursory inspections of the undisturbed ground surface within 100 centimetres from the base of each tree, followed (if no faecal pellets are initially detected) by a more thorough inspection involving disturbance of the leaf litter and ground cover within the prescribed search area. Each tree was searched for a period of approximately 2 minutes.

Opportunistic observations

Opportunistic and incidental observations of fauna species were recorded during field surveys. Survey effort was concentrated on suitable areas of habitat throughout the course of the fauna survey, for instance fallen timber and discarded corrugated iron was scanned for reptiles and large old trees were scanned for roosting birds.

Habitat assessment

A habitat assessment was conducted at each of the five sites. The aim of the habitat assessments was to document the relative quality of fauna habitat within each of the five study sites, with a particular focus on identifying habitat features for threatened fauna. Generally, the priority was to survey areas considered likely to represent threatened fauna habitat, thus survey work concentrated mainly on areas of natural vegetation, with cleared or semi-cleared areas given a lower priority.

The fauna habitat surveys were undertaken in association with the vegetation mapping; information about specific fauna habitat attributes was recorded for each of the five study sites. The approximate boundaries of each area of similar fauna habitat were recorded in the field using a hand-held GPS. Opportunistic observations of fauna species, particularly threatened or locally significant species, including searches for indirect evidence such as scats and owl pellets, were carried out in conjunction with the field habitat assessments.

Habitat searches recorded (if present):

- Quality of substrate for sheltering frogs and reptiles including rocks, logs, peeling bark, leaf litter and native grassland.
- Vegetation patch size, age, disturbance and structural diversity.
- Hollow-bearing trees.
- Disturbance regimes.
- Links to identified fauna corridors and/or adjoining forested lands.
- The potential habitat for threatened species.
- Stags and other roost sites for raptors and owls.

- Wetlands, moist grassland and other foraging habitat for water and migratory birds.

The habitat assessment was performed using a random meander technique, ensuring appropriate coverage of the study area and representative sampling of all habitat types present. Locations of important habitat features were captured with a handheld GPS unit and mapped using GIS.

Data analysis

The GPS information obtained in the field was downloaded into MapInfo and superimposed onto the layers containing the aerial photograph and proposed alignment. The GPS points for vegetation boundaries were used in combination with visual assessment of changes in vegetation types from the aerial photograph to produce a vegetation map of the study area.

Fauna habitat attributes recorded in the field were applied to the vegetation community mapping mentioned above using MapInfo and the potential for threatened species to occur was assessed.

Fauna habitats were assessed by examining characteristics such as native vegetation, ground and litter layers, breeding, nesting, feeding and roosting resources and evidence of fauna presence. The following criteria were used to evaluate habitat values:

- **High**: Fauna habitat components are usually all present (for example, old-growth trees, fallen timber, shrub stratum, groundcover, feeding and roosting resources etc) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Medium**: Some fauna habitat components are often missing (for example, old-growth trees, fallen timber, shrub stratum), although linkages with other remnant habitats in the landscape are usually intact, although often degraded.
- **Low**: Many fauna habitat elements in low quality remnants have been lost, including old-growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

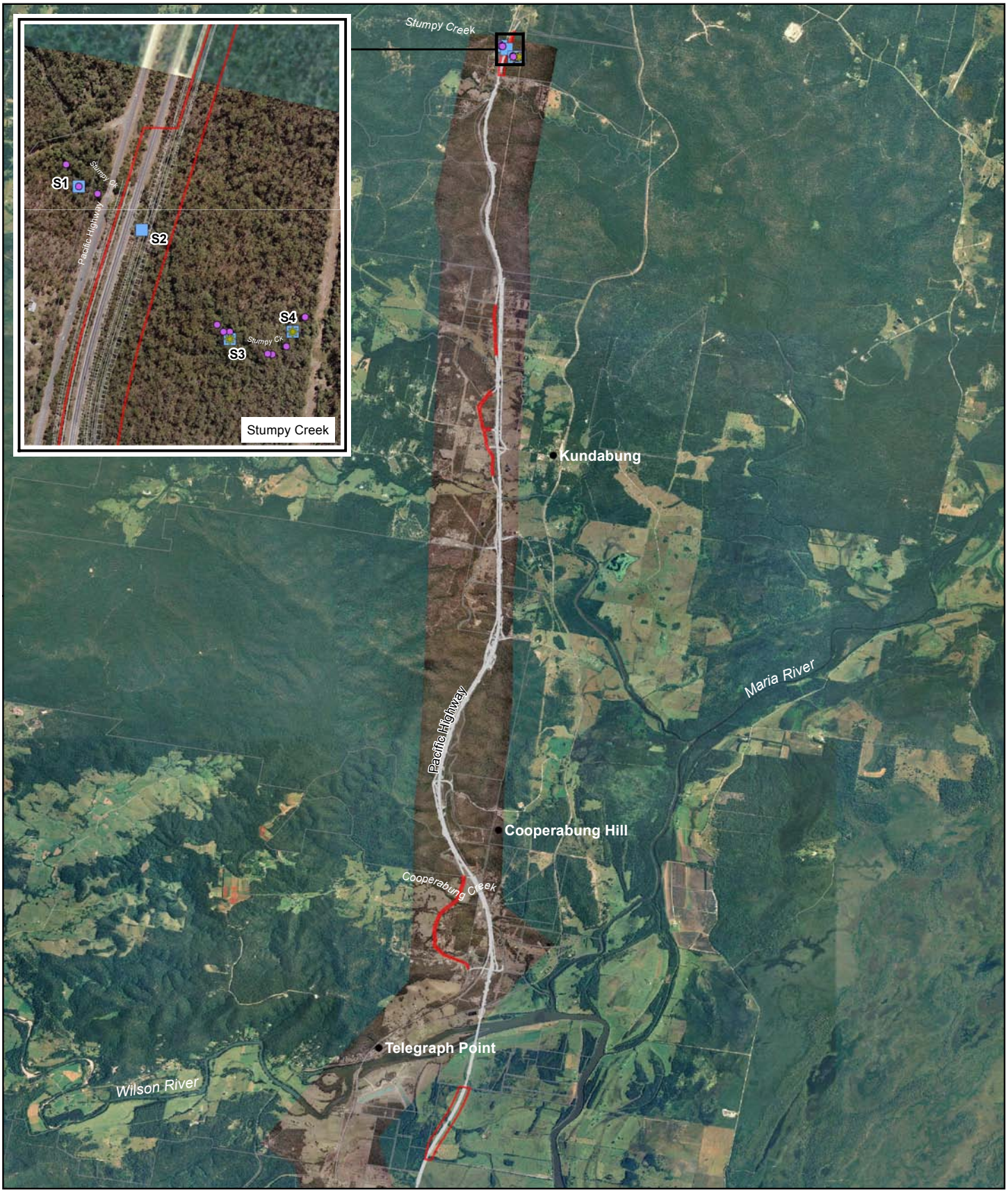
Freshwater wetland areas were difficult to classify using the same criteria and have been given a medium ranking, as while they do provide habitat for a range of species, these areas experience some level of ongoing disturbance due to grazing by cattle.

2.5 Aquatic ecology surveys

Aquatic ecology surveys were undertaken within 100 metres upstream and 300 metres downstream of where the Pacific Highway currently crosses Stumpy Creek, approximately 4 kilometres south of Kempsey, in accordance with the NSW Fisheries document *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation 1999* (DPI 1999). The 100 metre upstream limit was due to property access issues at the time of surveying. A combination of active and passive sampling techniques was used to target fish and assess habitat types.

Field sampling occurred on 3 and 4 November 2010. Fishing was carried out under the conditions set by the DII scientific collection permit (P07/0142-3.0) and Animal Ethics Authority. All fish were identified to species level and counted, weighed and measured before being returned to the water.

GPS coordinates for trap, net, water quality and habitat assessment locations were recorded at each site. Locations of the aquatic sampling sites are shown in **Figure 2-3**.



LEGEND

- Study Area
- Cadastre
- Concept Design
- Bait trap
- Fyke net
- Habitat Assessment & Water Quality

1:110,000 (at A4)

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Job Number	22-1374532
Revision	A
Date	02 DEC 2010

Aquatic Survey Site Locations

Figure 2.3

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

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Data Source: Geosciences Australia: Topography - 2007; GHD: Field Survey Data - 2010; Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton, fmackay

Aquatic survey methods

The following field survey methods were used during the aquatic ecology survey:

- Water quality analysis (temperature, pH, electrical conductivity, dissolved oxygen and turbidity).
- Habitat assessment, involving documentation of habitat attributes.
- Fish surveys, involving fyke nets and bait traps.

Watercourse type, aquatic habitat availability and water quality variables determined the most appropriate methods for conducting the fish surveys at each site. For example:

- Electro-fishing can only be conducted in waters with an electrical conductivity between 300 microsiemens per centimetre and 1100 microsiemens per centimetre.
- The setting of fyke nets requires a watercourse at least 20 metres long and no deeper than 1 metre.
- Bait traps are suitable for all waterway types, however require a minimum water depth of 300 millimetres.

Ideally, the proposed method of surveying fish species at each site was through both active and passive sampling methods (eg electrofishing, fyke netting and bait trapping (in order of preference)). **Table 2-2** shows the survey method(s) employed at each site and site specific variables restricting unused methods.

Table 2-2 Aquatic survey methods

Location	Habitat assessment	Water quality analysis	Electro-fishing		Fyke net		Bait trap	
			Used?	Comment	Used?	Comment	Used?	Comment
Upstream	Yes	Yes	No	EC outside operational range	No	Insufficient watercourse	Yes	Three sites
Mid	Yes	Yes	No	EC outside operational range	Yes	One site	Yes	Three sites
Downstream	Yes	Yes	No	EC outside operational range	Yes	One site	Yes	Four sites

Water quality

The field water quality results are assessed with respect to the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC/ARMCANZ 2000) trigger values for the protection of aquatic ecosystems at the 95 per cent level of protection.

The ANZECC (2000) trigger vales for physical or chemical stress in freshwater lowland rivers in south east Australia are as follows:

- Dissolved oxygen (percentage saturation): lower limit 85 per cent, upper limit 110 per cent.
- pH: lower limit: 6.5, upper limit 8.0.
- Electrical conductivity: lower limit 125 microsiemens per centimetre, upper limit 2200 microsiemens per centimetre.

- Turbidity: lower limit 6 nephelometric turbidity units (NTU), upper limit 50 NTU.

The main objective of the ANZECC/ARMCANZ Guidelines is to provide an authoritative guide for setting water quality objectives required to sustain current or likely future, environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand, as part of Australia's National Water Quality Management Strategy. They provide government and the general community (particularly catchment/water managers, regulators, industry, consultants and community groups) with a sound set of tools for assessing and managing ambient water quality in natural and semi-natural water resources.

The ANZECC/ARMCANZ Guidelines move away from setting fixed single number water quality criteria, and emphasise water quality criteria that can be determined on a case by case basis, according to local environmental conditions. The ANZECC/ARMCANZ Guidelines establish *default trigger values* that are set conservatively and can be used as a benchmark for assessing water quality. The trigger values for different indicators of water quality may be given as a threshold value or as a range of desirable values. Trigger values, being set as conservative assessment levels, are not 'pass/fail' compliance criteria. Because local conditions vary naturally between waterways, the default trigger values provided in ANZECC 2000 Guidelines, if exceeded, mean that further investigation is "triggered" for the pollutant concerned. Assessing whether the exceedance means a risk of impact to the relevant Water Quality Objective requires site-specific investigation, using decision trees provided in the Guidelines.

2.5.1 Summary of survey effort

A summary of the survey methods and effort and targeted species and groups for this supplementary investigation is provided in **Table 2-3**.

Table 2-3 Survey methods and effort

Targeted species / groups	Methodology	Survey hours
General reptiles and frogs	Hand searches, spotlight, auditory surveys	3 hours
Targeted frog survey	Spotlight, auditory survey and call playback	4.5 hours
Diurnal birds	Observation and call identification	8 hours
Nocturnal birds	Call playback and call identification	6 hours
Mammals and nocturnal birds	Spotlight surveys	18 hours
Arboreal mammals, microbats and nocturnal birds	Stag watch	1 hour
Small mammals	Ground-trapping - Elliott A traps	150 trap nights
Medium-sized mammals	Ground-trapping Elliott B traps	0 trap nights
Arboreal mammals	Tree-trapping – Elliott B Traps	80 trap nights 2 hours
Koala scat searches	Searches under food trees	8 hours
Microbats	Anabat II ultrasonic call recording	200 hours
Microbats	Harp traps	3 trap nights

Targeted species / groups	Methodology	Survey hours
Tree-hollow counts	Walked traverse of Proposal	8 hours
Fish	Fyke nets, bait traps, habitat assessment	12 trap nights 8 hours
Vegetation survey, mapping EECs, targeted threatened flora survey and fauna habitat assessments	Quadrats/transects	50 hours

2.6 Groundwater dependent ecological communities

Vegetated groundwater dependent ecological communities and their degree of dependence on groundwater were inferred from the floristics and structure of the vegetation, known correlations with groundwater systems, and their position in the landscape. Rivers and streams are assumed to be groundwater dependent. Impact assessment has considered impacts on groundwater dependent ecological communities in accordance with the NSW *State Groundwater Dependant Ecosystem Policy 2002*.

3. Description of the existing environment

3.1 Vegetation communities

3.1.1 Vegetation of the study area

Ten natural vegetation communities in an advanced state of regrowth or regeneration and three artificial or highly modified vegetation communities were recorded during the prior field surveys within the Proposal footprint, these communities are listed below and described in detail in Section 3.2 of the Working Paper (GHD 2010a).

Natural communities

1. Moist Floodplain Closed Forest with Rainforest Elements.
2. Riparian Forest.
3. Paperbark Swamp Forest.
4. Swamp Mahogany / Forest Red Gum Swamp Forest.
5. Swamp Oak Forest.
6. Freshwater Wetland.
7. Moist Floodplain Forest.
8. Moist Gully Forest.
9. Moist Slopes Forest.
10. Dry Ridgetop Forest.

Artificial or highly modified communities

11. Cleared, Open Grassland / Derived Pasture with scattered trees.
12. Plantation / Cropland / Market Garden etc.
13. Totally Cleared Open Pasture / Weedy Fallow.

In addition to these communities, open water in creeklines, ponds and farm dams provides habitat for frogs and water birds, as well as a focal foraging area for insectivorous bats and birds. These features could occur in any of the identified vegetation communities, although permanent and ephemeral wet areas are generally found in communities 1, 2, 3, 4, 5, 6 and 7.

Seven of the 13 vegetation communities that were described in the Working Paper (GHD 2010a) are present within the study sites (communities 3, 5, 6, 7, 8, 10 and 13). Vegetation types present at each study site are described in detail below and shown in **Figure 3-1** to **Figure 3-5**.

Table 3-1 shows where the native vegetation communities occur within the study area and how many hectares are likely to be removed (note that community 13 is an artificial or highly modified community and so is not included in the table). However, at this stage it is unknown how much vegetation will actually require removal along each of the service roads. These impacts for these areas in terms of vegetation removal have therefore have not been included in the table (ie the table only shows areas of native vegetation proposed to be removed in Lot 1 DP 6242147 and Lot 80 DP 737375).

Table 3-1 Native vegetation communities identified within study area

No	Community name	Location within the study area	Approximate area impacted in study area (ha)
3	Paperbark Swamp Forest	Lot 1 DP 624217	1.7
5	Swamp Oak Forest	Lot 1 DP 624217	0.8
6	Freshwater Wetland	Lot 1 DP 624217	0.1
7	Moist Floodplain Forest	Lot 80 DP 737375 Ravenswood Road	1.2
8	Moist Gully Forest	Ravenswood Road Rodeo Drive Cooperabung Drive	1.6
10	Dry Ridgetop Forest	Ravenswood Road Rodeo Drive Cooperabung Drive Lot 80 DP 737375	0.4
Total native vegetation removal			***5.8***

3.1.2 Lot 80 DP 737375 – Stumpy Creek

The vegetation cover within this lot is consistent with the broad vegetation descriptions for Moist Floodplain Forest (Community 7), Moist Gully Forest (Community 8) and Dry Ridgetop Forest (Community 10) provided in Section 3.2 in the Working Paper (GHD 2010a). The distributions of these communities across the site are shown in **Figure 3-1** and are described in detail below:

Moist Floodplain Forest (Community 7)

This open forest is located within a narrow floodplain flanking the riparian corridor either side of Stumpy Creek. The open canopy is dominated by *Syncarpia glomulifera* (turpentine), *Eucalyptus resinifera* (red mahogany) and *E. microcorys* (tallowwood) to 25 metres tall. The shrub layer is dominated by *Babingtonia similis, Callistemon salignus* (willow bottlebrush) and *Calochlaena dubia* (false bracken). The ground layer is diverse with common species including *Oplismenus aemulus* (basket grass), *Dichondra repens* (kidney weed), *Hydrocotyle tripartita* (pennywort) and *Entolasia stricta* (wiry panic).

Within the riparian zone fringing Stumpy Creek, *Melaleuca linariifolia* (snow-in-summer) becomes more common along with a number of fern species.

Plate 1 Moist floodplain forest vegetation community (Stumpy Creek north)

Moist Gully Forest (Community 8)

This vegetation association occurs along a drainage channel, south of Stumpy Creek on a gentle north facing slope. Dominant species include *Eucalyptus microcorys* (tallowwood) and *E. tereticornis* (forest red-gum) to 20 metres tall. The shrub layer comprises dense thickets of *Babingtonia similis* and *Leptospermum polygalifolium* (tantoon). The ground layer is dominated by a dense cover of *Entolasia stricta* (wiry panic) with other common species, including *Lomandra longifolia* (spiny-headed mat rush), *Gahnia sieberi* (red-fruited saw-sedge) and *Pteridium esculentum* (austral bracken).

Plate 2 Moist gully forest vegetation community (Stumpy Creek south)

Dry Ridge-top Forest (Community 10)

This open forest occurs on a gentle slope at the northern end of the study area. Dominant trees include *Corymbia intermedia* (pink bloodwood), *Eucalyptus carnea* (broad-leaf white mahogany) and *E. pilularis* (blackbutt) to 22 metres tall over a dense understorey of *Allocasuarina littoralis* (black she-oak), *Callistemon salignus* (willow bottlebrush) and *Acacia maidenii* (maiden's wattle) to 10 metres tall. Associated canopy species include *Eucalyptus propinqua* (small-fruited grey gum), *Eucalyptus microcorys* (tallowwood) and *Eucalyptus tereticornis* (forest red gum). The ground layer is sparse with occasional herbs and grasses growing in a thick litter layer dominated by Allocasuarina needles.

Although there is some evidence of historic disturbance with the forest currently in an advanced stage of regrowth, overall the community is in good condition with very few weeds and a number of large hollow-bearing trees scattered throughout.

Plate 3 Dry ridge-top forest vegetation community (Stumpy Creek north)

3.1.3 Lot 1 DP 624217

Four vegetation communities are present within this property, these correlate with the following broad vegetation types described in **Section 3.2** of the Working Paper (GHD 2010a). Vegetation mapping for this property is shown in **Figure 3-2**.

Paperbark Swamp Forest (Community 3)

This community occurs on the floodplains of the Wilson River. The community is an open forest dominated by *Melaleuca quinquenervia* (broad-leaved paperbark) to 25 metres tall with occasional *Eucalyptus robusta* (swamp mahogany) also present. The sub-canopy consists primarily of *Casuarina glauca* (swamp she-oak) over a sparse shrub layer of *Gahnia sieberi* (red-fruited saw-sedge), *Lantana camara* (lantana) and *Calochlaena dubia* (false bracken fern). The understorey is dominated by *Entolasia marginata* (boarded panic) and *Paspalum urvillei* (vasey grass). At the time of the assessment there were standing pools of water throughout this community.

Although the canopy and shrub layer are largely intact the overall condition of this community is considered to be moderate due to the disturbance regimes associated with grazing activities on this property which have contributed to the dominance of introduced grasses within the ground layer.

Plate 4 Paperbark swamp forest vegetation community (Lot 1 DP 624217)

Swamp Oak Forest (Community 5)

This community occurs as a narrow patch within a low-lying poorly drained depression at the northern end of the property. The community is dominated by *Casuarina glauca* (swamp oak) to 20 metres tall over a degraded understorey dominated by *Paspalum urvillei* (vasey grass). Overall the community is in poor condition with a largely absent mid-storey and ground layer dominated by exotic species.

Plate 5 Swamp oak forest vegetation community (Lot 1 DP 624217)

Freshwater Wetland (Community 6)

Immediately north-west of the Proposal is an expanse of permanently wet ground characterised by emergent and aquatic plant species, an area connected with the Wilson and Maria river floodplain. Mostly native species were observed within this area of inundation including *Juncus mollis*, *Juncus prismatocarpus*, *Philydrum lanuginosum* (frogmouth) and *Persicaria decipiens* (knotweed). This community is not within the direct Proposal footprint but could potentially be indirectly affected by the Proposal.

Plate 6 Freshwater wetland vegetation community (Lot 1 DP 624217)

Totally Cleared / Open Pasture / Weedy Fallow (Community 13)

This community occurs within previously cleared and grazed lands. The vegetation characteristics of this area have been simplified to almost exclusively introduced pasture grasses. The introduced species *Axonopus fissifolius* (carpet grass) dominates this community. Isolated occurrences of native herbs and sedges are apparent in wetter soaks, including species such as *Carex* spp. and *Persicaria* spp. (knotweed).

Plate 7 Open pasture (Lot 1 DP 624217)

3.1.4 Service roads

The dominant vegetation communities within the road reserves of Cooperabung Drive, Rodeo Drive and Ravenswood Road correspond to the following broad vegetation types described in Section 3.2 of the Working Paper (GHD 2010a). Broadly speaking the communities are comparable in that they largely comprise similar species, however differences arise in structure and relative cover abundances. These differences are attributed to changes in landscape position and disturbance history. Vegetation mapping for each of these service roads is shown in **Figure 3-3** to **Figure 3-5**.

Moist Gully Forest (Community 8)

This community is found at the base of undulating hills and sheltered gullies and is typically associated with ephemeral drainage lines and minor creeks. This open forest is typically dominated by *Eucalyptus saligna* (Sydney bluegum), *E. tereticornis* (forest red-gum) and *E. resinifera* (red mahogany) to 20 metres over a shrub layer dominated by *Melaleuca nodosa, A. linifolia* (narrow-leaf wattle) and *Allocasuarina torulosa* (black she-oak). Common species within the ground layer include *Imperata cylindrica* (blady grass), *Microlaena stipoides* (weeping grass), *Dichondra repens* (kidney weed) and *Entolasia stricta* (wiry panic).

This community has been significantly disturbed and is generally in poor condition with low structural diversity and a high abundance of introduced species.

Plate 8 Moist gully forest vegetation community (Cooperabung Road)

Dry Ridge-top Forest (Community 10)

This community forms a tall open forest that is dominated by *Eucalyptus microcorys* (tallowwood), *E. propinqua* (small-fruited grey-gum) and *E. siderophloia* (northern grey-ironbark).

The tree layer is typically dominated by *Eucalyptus propinqua* (small-fruited grey-gum), *E. microcorys* (tallowwood), *Eucalyptus globoidea* (white stringy-bark), *Corymbia intermedia* (pink bloodwood) and *E. resinifera* (red mahogany) to 20 metres over a shrub layer dominated by, *A. linifolia* (narrow-leaf wattle) and *Allocasuarina littoralis* (black She-oak). Common species within the

ground layer include *Imperata cylindrica* (blady grass), *Themeda australis* (kangaroo grass), *Dianella caerula* (blue flax-lily) and *Entolasia stricta* (wiry panic).

The quality of the community varies from very good condition in sections with a relatively intact canopy, shrub and ground with a low abundance of weeds (ie northern parts of Ravenswood Road and Rodeo Drive) to areas where the understorey of the community has been completely removed leaving only scattered trees (ie southern parts of Rodeo Drive and Ravenswood Road and most of Cooperabung Drive).

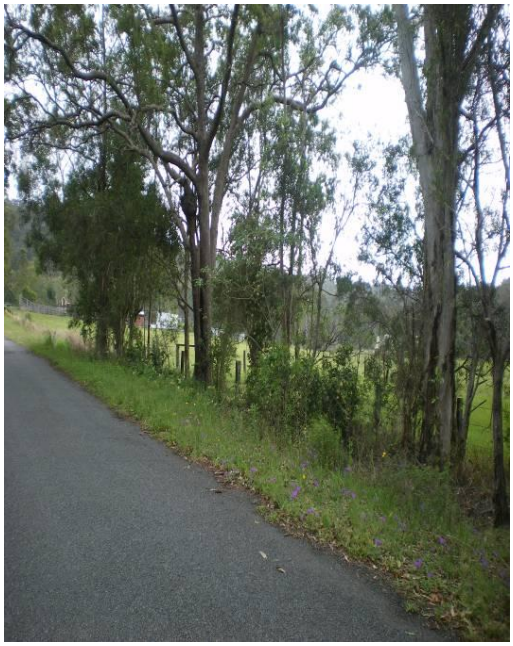


Plate 9 & Plate 10 Dry ridge-top forest of varying quality (Ravenswood Road)

Moist floodplain forest (Community 7)

Along Cooperabung Drive, this open forest occurs on the floodplain of Cooperabung Creek. The community is dominated by *Eucalyptus tereticornis* (forest red gum), *Eucalyptus resinifera* (red mahogany) and *Corymbia intermedia* (pink bloodwood) to 25 metres tall over a heavily disturbed shrub and ground layers. Weed abundance is high throughout the community with the invasive species *Lantana camara* (lantana) forming dense thickets. Other common weeds growing within this community include *Verbena bonarienensis* (purpletop) and *Paspalum* sp.

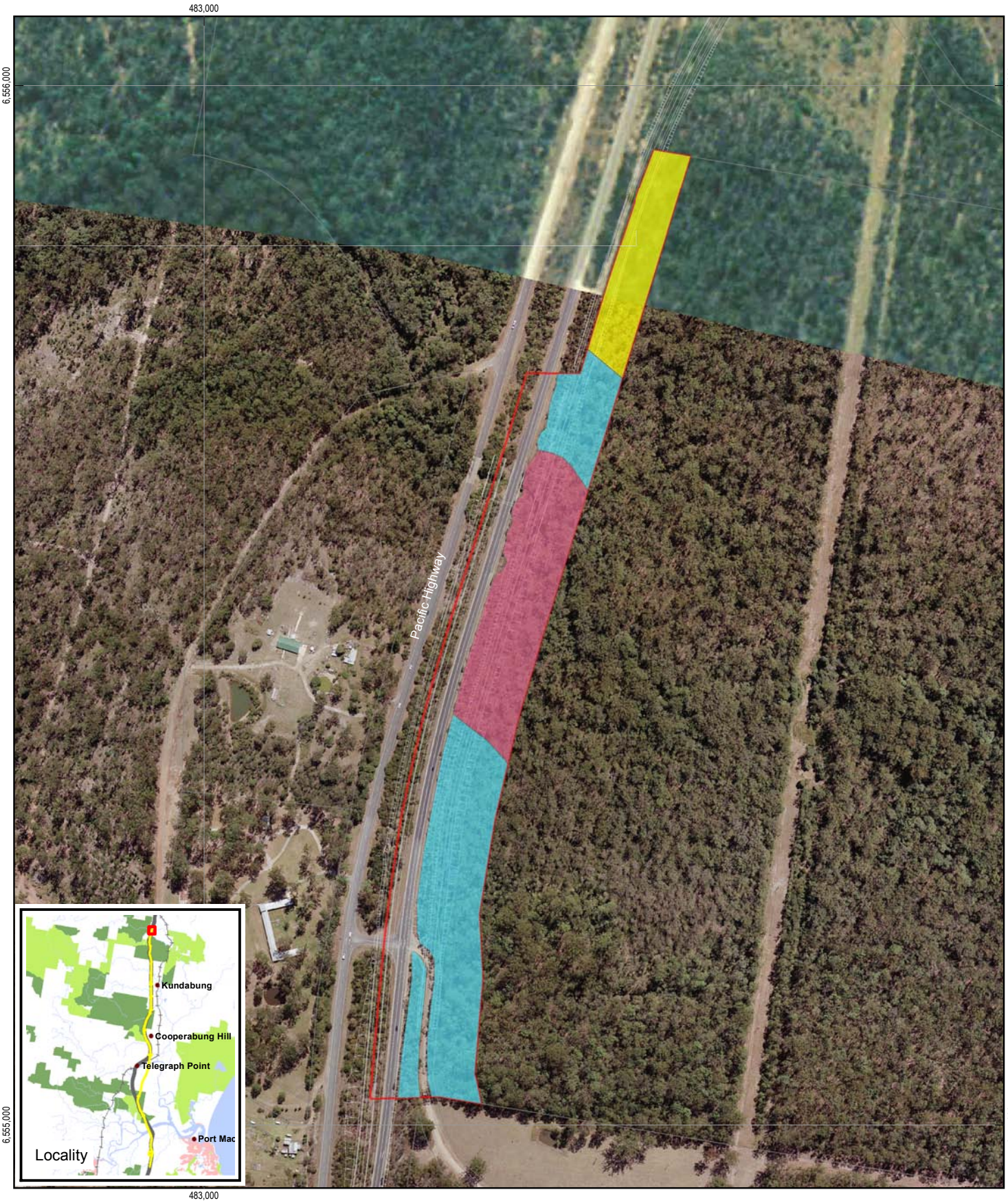
Plate 11 Moist floodplain forest (Cooperabung Road)

Cleared, Open Grassland / Derived Pasture with scattered trees (Community 12)

There are numerous areas along each of the service roads that have been cleared of native vegetation and are dominated either entirely by exotic species or have remnant scattered trees over an exotic understorey. Exotic species are most common within roadside drains and location where the road intersects a natural drainage line. Exotic species richness and cover abundance is heightened by the elongated edge effect often associated with roads where increased light, nutrients and recruitment process often favour the occupation of these species.

Plate 12 Exotic grassland Rodeo Drive

Plate 13 – Scattered trees Ravenswood Road



LEGEND

- Study Area
- Cadastre
- Concept Design
- Dry Ridgetop Forest
- Moist Floodplain Forest
- Moist Gully Forest

1:5,000 (at A4)

0 20 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 05 NOV 2010

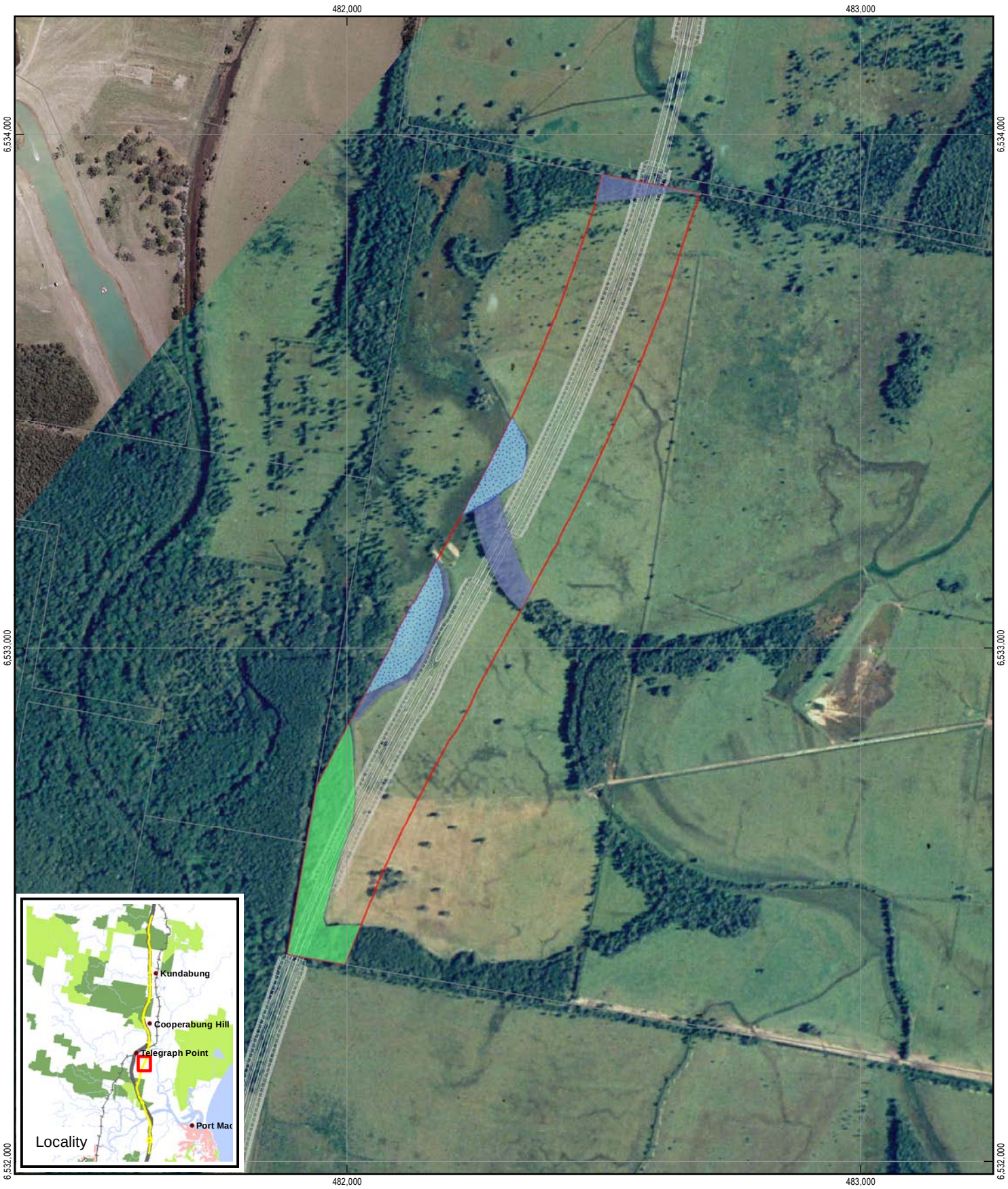
Lot 80 DP737375 (Stumpy Creek) Vegetation Mapping

Figure 3.1

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

C:\GIS\1205704\Additional Field Survey Maps\OHK_AFS_003_Vegetation_Mapping_20101110_A_V93.mxd

Data Source: Geosciences Australia: Topography - 2007; NSW Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton



LEGEND

- Study Area
- Cadastre
- Concept Design
- Freshwater Wetland
- Paperbark Swamp Forest
- Swamp Oak Forest

1:10,000 (at A4)

0 45 90 180 270 360

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Lot 1 DP624217
Vegetation Mapping

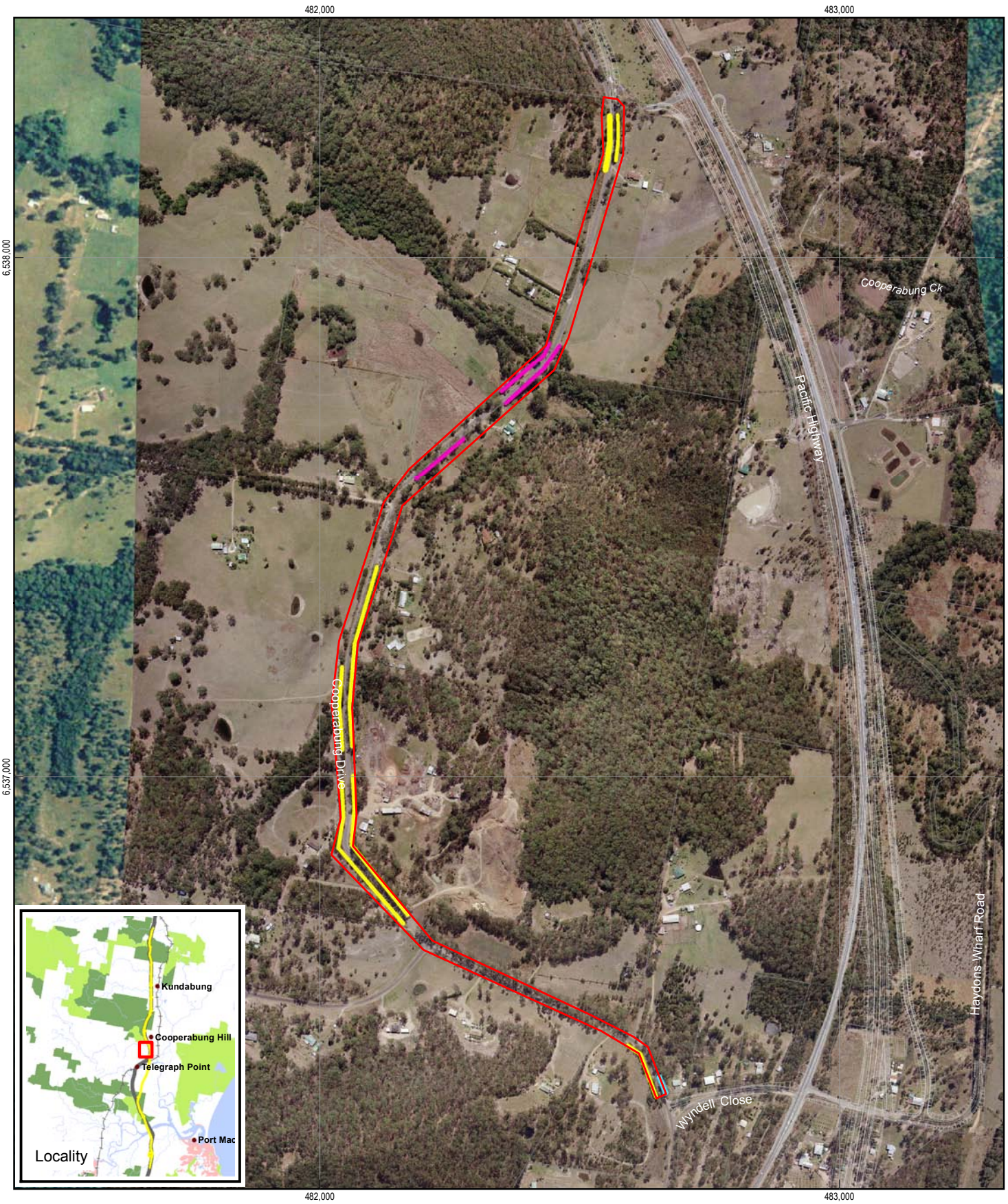
Job Number	22-1374532
Revision	A
Date	25 FEB 2011

Figure 3.2

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_005_Vegetation_Mapping_3-2_20101110_A.mxd

Data Source: Geosciences Australia: Topography - 2007; NSW Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton



LEGEND

- Study Area
- Cadastre
- Concept Design
- Dry Ridgetop Forest
- Moist Floodplain Forest
- Moist Gully Forest

1:10,000 (at A4)

0 45 90 180 270 360

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

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Roads and Traffic Authority
Additional Field Survey

Cooperabung Drive Vegetation Mapping

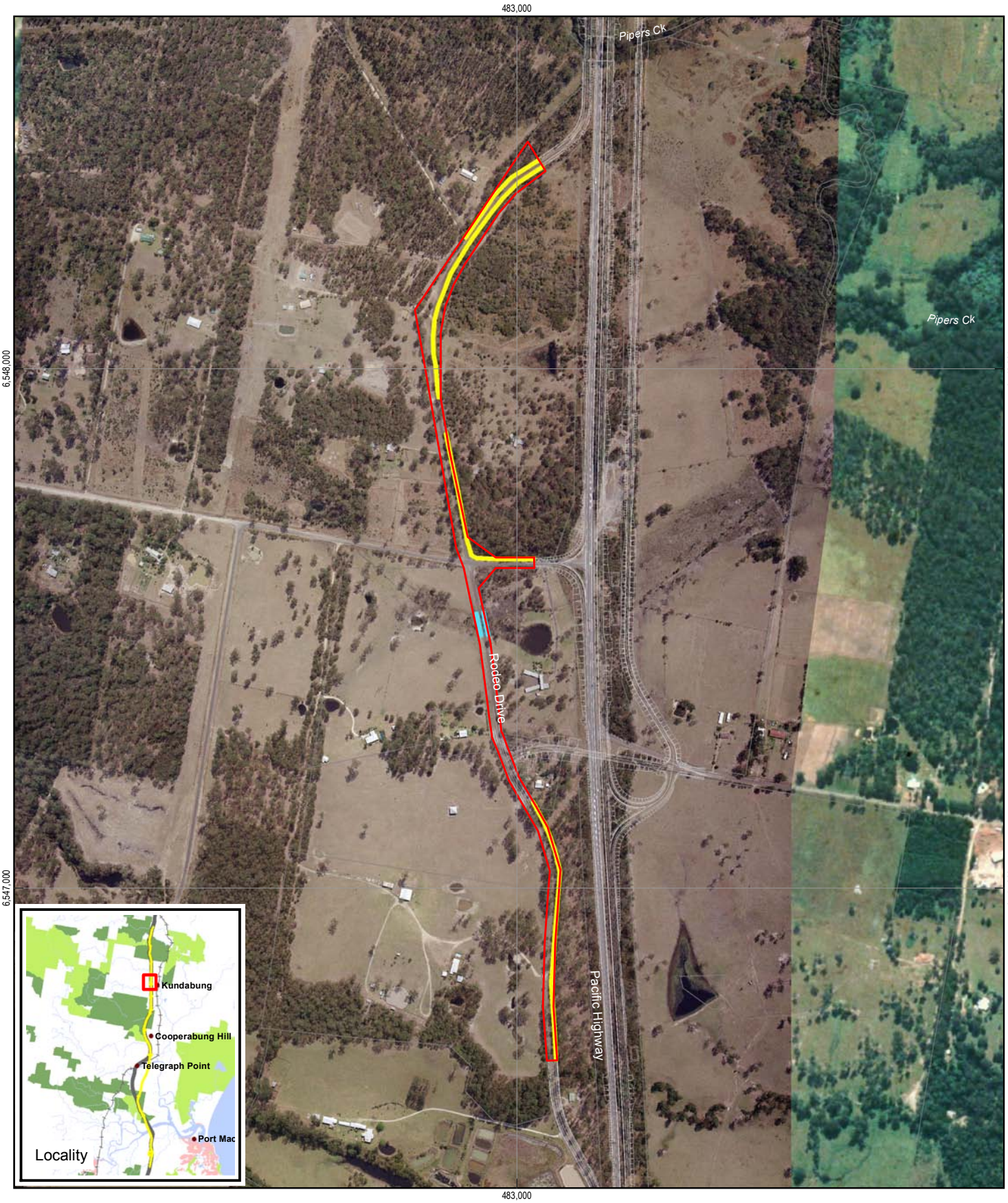
Job Number 22-1374532
Revision A
Date 02 DEC 2010

Figure 3.3

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_006_Vegetation_Mapping_3-3_20101110_A.mxd

Data Source: Geosciences Australia: Topography - 2007; NSW Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton, fmackay



LEGEND

- Study Area
- Cadastre
- Concept Design
- Dry Ridgetop Forest
- Moist Gully Forest

1:10,000 (at A4)

0 45 90 180 270 360

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Rodeo Drive Vegetation Mapping

Job Number 22-1374532
Revision A
Date 02 DEC 2010

Figure 3.4

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_007_Vegetation_Mapping_3-4_20101110_A.mxd

Data Source: Geosciences Australia: Topography - 2007; NSW Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton, fmackay

LEGEND

- Study Area
- Cadastre
- Concept Design
- Dry Ridgetop Forest
- Moist Gully Forest

1:10,000 (at A4)

0 45 90 180 270 360

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

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Roads and Traffic Authority
Additional Field Survey

Ravenswood Road Vegetation Mapping

Job Number 22-1374532
Revision A
Date 02 DEC 2010

Figure 3.5

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_008_Vegetation_Mapping_3-5_20101110_A.mxd

Data Source: Geosciences Australia: Topography - 2007; NSW Department of Lands: Cadastre - 2007; GHD: Concept Design - 2010; Hastings Shire Council: Spatial Layers - 2008. Created by: tmorton, fmackay

3.2 Flora diversity

Because of the extent of past clearing and ongoing disturbance within the study area, the vegetation is either much simplified or characterised by various degrees of modification compared to its original condition.

A total of 160 flora species were recorded during the additional surveys. This total includes weeds and planted or cultivated species. The proportion of introduced species overall was approximately 17 per cent, indicating a moderate level of exotic species presence. The full list of flora species recorded is presented in **Appendix D**.

3.3 Threatened terrestrial flora

No threatened flora species listed under either the NSW TSC Act or Commonwealth EPBC Act or rare species on the Rare or Threatened Australian Plants database were recorded within the study area during the additional flora and fauna surveys.

From searches of the DECCW Atlas of NSW Wildlife and the SEWPAC EPBC Act Protected Matters Search Tool, 19 threatened flora species have been previously recorded within the study locality or have distribution ranges that overlap the study area. An assessment of the likelihood of species occurrence in the study area is presented in **Appendix F.**

Of the threatened plant species identified by the database searches, five threatened species have the potential to occur in the study area. This includes one species (*Hakea archaeoides* (big Nellie hakea)) that was not considered in the Working Paper (GHD 2010a).

Flora species with potential to occur within the study area are shown in **Table 3-2**. None of these species have been recorded during the current or previous surveys. The previous unconfirmed records for scented acronychia were not verified during targeted surveys undertaken during this assessment.

Table 3-2 Threatened plant species with the potential to occur in the study area

Species	Location	TSC Act status	EPBC Act status
Scented acronychia (*Acronychia littoralis)*	2 unconfirmed records near Fernbank Creek and the Wilson River, as well as several records on the coast near Port Macquarie. Recent plant collections from Lot 1 DP 624217 indicate these unconfirmed records as being erroneously identified (*Acronychia oblongifolia*).	Endangered	Endangered
Hairy-joint grass (*Arthraxon hispidus*)	Recorded within 2 km of the existing highway at Kundabung.	Vulnerable	Vulnerable
Milky silkpod (*Parsonsia dorrigoensis*)	1 record on the coast near Port Macquarie.	Vulnerable	Endangered
Swamp orchid (*Phaius tancarvilleae*)	Not previously recorded in the study locality but is known to occur in northern NSW.	Endangered	Endangered
Southern swamp orchid (*Phaius australis*)	Not previously recorded in the study locality but is known to occur in the vicinity of, and north of, Port Macquarie (HWR Ecological 2005a).	Endangered	Endangered

3.4 Endangered populations

One endangered population, the Emu (*Dromaius novaehollandiae*) population in the NSW North Coast Bioregion and Port Stephens Local Government Area, is known from the study locality. This population is listed on Part 2 of Schedule 1 of the TSC Act.

Emus are distributed broadly but patchily through NSW. They occupy a range of predominantly open habitats, including plains, grasslands, woodlands and shrubs, and may occur occasionally in forest.

An isolated population of Emus occurs in the NSW North Coast Bioregion and Port Stephens local government area. The population is disjunct from other populations in the Sydney Basin and New England Tableland Bioregion. The population of Emus in the NSW North Coast Bioregion and Port Stephens local government area represents the north-eastern limit of the species in NSW. The majority of recent records are concentrated between Coffs Harbour and Ballina, with occasional records inland of the coastal ranges.

There are no local records of Emus within the immediate vicinity of the study area and it is highly unlikely that this population occurs within the study area.

3.5 Endangered ecological communities

Three EECs listed under the TSC Act are present in the study area. These EECs were all recorded on Lot 1 DP 624217. Descriptions of these EECs are provided below.

Swamp Oak Floodplain Forest of the NSW North Coast Sydney Basin and South East Corner Bioregions

This EEC occurs in low-lying permanently wet depressions with poor drainage on floodplains, with some saline influence. The community occurs as a forest or open forest dominated by swamp oaks, occasional paperbarks and usually with a rush or sedge understorey. Eucalypts are usually absent or uncommon. Within the additional study areas, this EEC is restricted to one small patch on the northern side of Lot 1 DP 624217 (corresponding to Paperbark Swamp Forest vegetation community). This occurs on the floodplain south of the Wilson River. This patch is in poor condition. The entire understorey comprises herbaceous weeds and exotic pasture grasses have invaded the understorey.

This EEC aligns with the mapped Swamp Oak Forest (vegetation community 9) shown in **Figure 3-2**.

Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney basin and South East Corner Bioregions.

Within the study area this community occurs in the low-lying areas at the south-western end of Lot 1 DP 624217. The community consists of a dense tree layer of paperbarks with scattered eucalyptus trees emerging from the canopy. *Melaleuca quinquenervia* (broad-leaf paperbark) dominate the canopy cover along with occasional *Eucalyptus robusta* (swamp mahogany) and *E. tereticornis* (forest red-gum). Mid-storey species include *Callistemon salignus* (willow bottlebrush), *Glochidion ferdinandi* (cheese tree) and *Casuarina glauca* (swamp oak). There are numerous vines and creepers throughout the community including *Stephania japonica* (snake vine) and *Parsonsia straminea* (common silk-pod).

The groundcover is mostly composed of the introduced *Paspalum urvillei* (vasey grass) with occasional natives grasses, herbs and sedges. These include *Gahnia sieberi (*red-fruited saw-sedge)*, Calochlaena dubia* (false bracken), *Viola hederacea, Entolasia marginata* (wiry panic) and *Imperata cylindrica* (blady Grass).

This EEC aligns with the mapped Paperbark Swamp Forest (vegetation community 3) shown in **Figure 3-2**.

Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions

This EEC occurs in low lying areas on floodplains associated with or near watercourses. The community has shallow fresh water containing or surrounded by macrophytes, sedges, rushes and other aquatic plants, generally less than 1.5 metres in height, and is often fringed by paperbarks and swamp oaks. Within Lot 1 DP 624217 this EEC was recorded to the immediate west of the Proposal boundary within an area connected with the Wilson and Maria river floodplain. The community occurs within an expanse of permanently wet ground characterised by emergent and aquatic plant species. The community is in good condition with mostly native species present within this area of inundation, including *Juncus mollis*, *Juncus prismatocarpus*, *Philydrum lanuginosum* (frogmouth) and *Persicaria decipiens* (knotweed).

This EEC aligns with the mapped Freshwater Wetland vegetation community (vegetation community 6) shown in **Figure 3-2**.

3.6 Terrestrial fauna habitats

3.6.1 Habitat attributes

A variety of habitat types with high structural and floristic diversity occur throughout the study area. These habitats provide diverse resources for a large variety of native flora and fauna, including threatened species.

Key habitat elements identified within the study area include:

- Flowering tree and shrub species within the forest communities and roadside environments, providing a year-round supply of foraging resources for nectarivorous and insectivorous bird, bat and arboreal mammal species.
- Shedding bark on paperbark trees, providing potential shelter sites for reptiles and microchiropteran bats.
- Paperbarks (*Melalueca* sp.) and swamp mahogany within the Paperbark Swamp Forest stands, providing important autumn/winter foraging resources for nectar-feeding birds, bats and arboreal mammals in the study area, including the threatened grey-headed flying fox.
- Hollow-bearing trees of importance to hollow-dependent fauna species, including seven threatened species recorded in the study area (ie east-coast freetail-bat, eastern false pipistrelle [possible identification only], greater broad-nosed bat [probable identification only] and hoary wattled bat [probable identification only]).
- Known habitat for koalas, including feeding resources such as tallowwood, small-fruited grey gum, forest red-gum, broad-leaved paperbark, swamp mahogany and scribbly gum.

- Known foraging habitat for glossy black-cockatoos. Two species of preferred feed trees for this species, black she-oak (*Allocasuarina littoralis)* and forest oak (*Allocasuarina torulosa)*, occur in the study area and are common within the dry ridgetop forest community.
- Grass and sedge species, and dense groundcover within the Paperbark Swamp Forest community provide suitable foraging resources for granivorous and herbivorous fauna and a range of reptiles and frogs.
- Areas of dense groundcover vegetation and soft substrate, providing suitable shelter and foraging habitat for a variety of small terrestrial mammals, including bandicoots, native rodents and marsupials. The threatened long-nosed potoroo is considered to potentially occur in the study area on the basis of the suitability of such habitat.
- Existing bridges and culverts provide roost sites for microchiropteran bats.
- Artificial and natural waterbodies provide important water sources for fauna as well as specific foraging and breeding habitat for frogs and waterbirds as well as foraging habitat for the southern myotis.

Tree-hollows

Tree-hollows within the study area provide potential shelter and nesting sites for a large number of arboreal mammals, birds, including large forest owls and parrots, as well as tree-dwelling microchiropteran bats, some reptiles, frog and invertebrate species. Large tree-hollows are restricted to Lot 80 DP 737375 (Stumpy Creek) as shown in **Figure 3-6**.

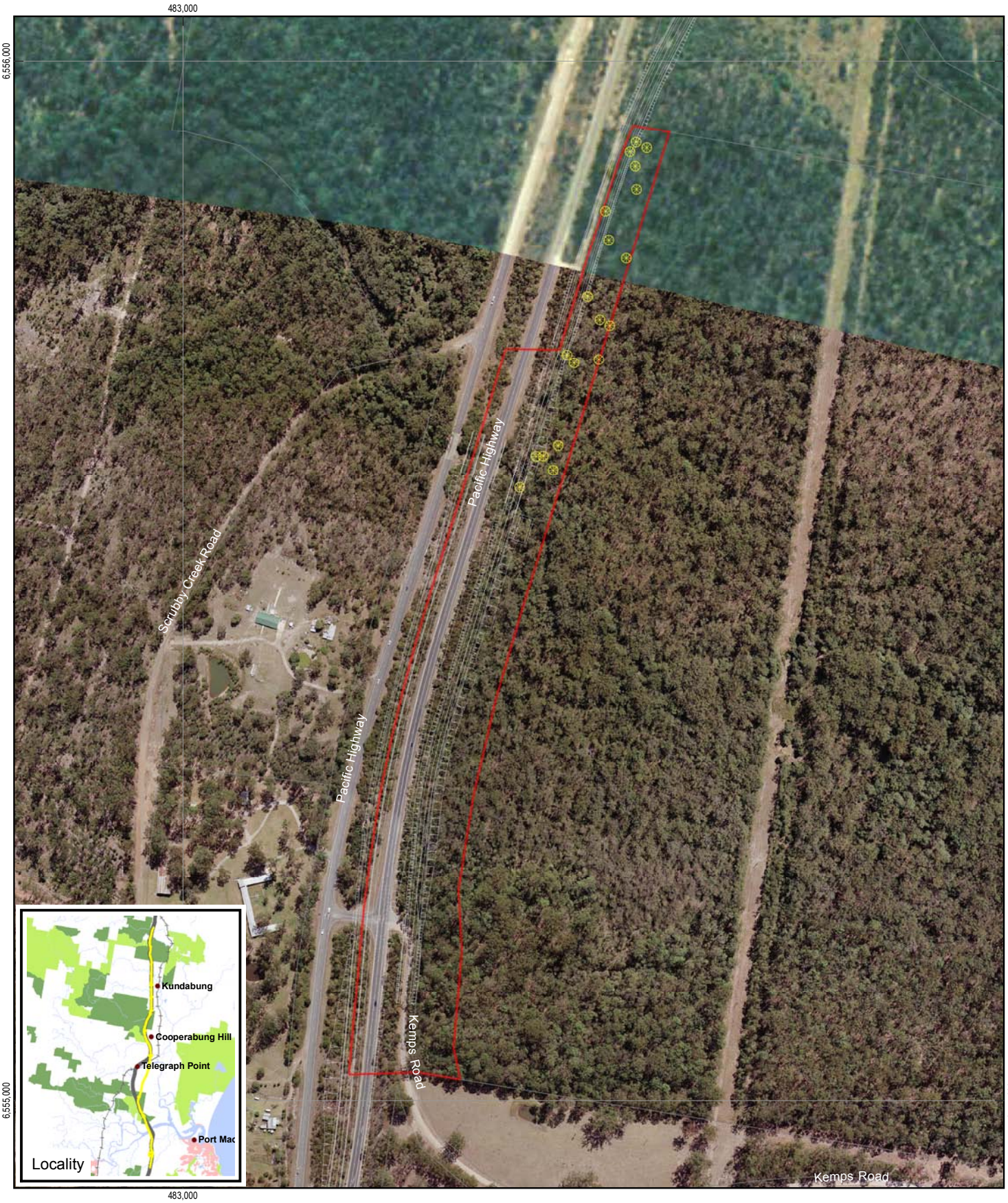
Tree-hollows of various sizes are present but not abundant within drier vegetation communities within the study area. Tree-hollows of varied sizes were abundant in the Moist Forest within Lot 80 DP 737375 with suitable for larger species, including the threatened glossy black-cockatoo, masked owl, sooty owl and yellow-bellied glider. Hollows potentially suitable for smaller species (including threatened microchiropteran bats) were found throughout all of the study area.

Koala habitat assessment

Koala feed tree species listed on Schedule 2 of *State Environmental Planning Policy 44 – Koala Habitat Protection* (SEPP 44) that occur within the additional study area are listed in **Table 3-3**. In addition to these, three primary koala browse tree species for the Port Macquarie-Hastings local government area (Connell Wagner 2000) were recorded within the study area: small-fruited grey gum *(Eucalyptus propinqua*), broad-leaved paperbark *(Melaleuca quinquenervia*) and blackbutt *(Eucalyptus pilularis*). One or more of these species occur in all of the mapped natural vegetation communities and also exist as scattered trees.

Table 3-3 Koala feed trees found in the additional study areas

Scientific name	Common name
Eucalyptus tereticornis	Forest red gum
Eucalyptus pilularis	Blackbutt
Eucalyptus microcorys	Tallowwood
Eucalyptus propinqua	Small-fruited grey gum
Eucalyptus signata	Scribbly gum
Eucalyptus robusta	Swamp mahogany



LEGEND

- Study Area
- Cadastre
- Concept Design
- Hollow trees

1:5,000 (at A4)

0 20 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Additional Field Survey

Job Number 22-1374532
Revision A
Date 10 NOV 2010

Lot 80 Dp737375 (Stumpy Creek)
Tree hollow locations

Figure 3.6

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com.au **W** www.ghd.com.au

C:\GIS\1205704\Additional Field Survey Maps\OHK_AFS_009_Tree_HollowLocations_20101110_A_V93.mxd

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: tmorton

Koala feed trees are present in most vegetation communities within the study area, and are common to dominant (constituting more than 15 per cent as defined under SEPP 44) within moist floodplain forest, moist slope forest and dry ridgetop forest communities.

Individual koalas could occur along much of the entire Proposal route. The naturally vegetated roadsides of Rodeo Drive and Ravenswood Road north in particular represent good potential koala habitat, with a high concentration of tallowwood and small-fruited grey gum found in dry ridgetop forest and moist slopes forest. Additionally, koala feed trees were present in all other vegetation communities apart from swamp oak forest and totally cleared open pasture/ weedy fallow.

The results of the database searches indicate numerous koala records within the study area (DECCW 2010). A considerable quantum of records is centred on the Rodeo Drive and Ravenswood Road area, this consistent with the occurrence of preferred feed trees. Further details on the importance of the study locality for the koala are outlined in the Flora and Fauna Working Paper (GHD 2010a).

The results of past and present field surveys combined with the number of records along the Proposal length indicate the presence of core koala habitat defined under SEPP 44. This is defined as an area of land with a resident population of koalas, evidenced by attributes such as recent sightings, breeding individuals and historical records of a population. This conclusion is particularly relevant to roadside environments at Rodeo Drive and Ravenswood Road, with parts of the Cooperabung Drive also considered important (Connell Wagner 2000).

Further commentary on the Proposal's impact on the koala in terms of relevant draft comprehensive koala plan of management prepared under the provisions of *State Environmental Planning Policy No. 44 – Koala Habitat Protection* is discussed in the Working Paper (GHD, 2010a). These plans are the Draft Kempsey Comprehensive Koala Plan of Management and Draft Hastings Comprehensive Koala Plan of Management.

3.6.2 Habitat types

Community types identified through vegetation mapping (**Figure 3-1** to **Figure 3-5**) constituted a good basis for assessing the availability and quality of various habitat types throughout the study area. The National Parks and Wildlife Service Key Habitats and Corridors in North East NSW Mapping Project (NPWS 2005) was also used to assist in determining overall fauna habitat values of vegetation communities.

The relative quality of fauna habitat has been based on the following features:

- Presence of large dead or living trees and hollow-bearing trees.
- Tree species richness and canopy cover including proportions of preferred koala feed tree species.
- Density of shrub and ground cover.
- Presence of fallen timber and rock outcrops.
- Presence of wet areas and waterbodies.
- Disturbance regimes (for example, logging, weed infestations, clearing and grazing).
- The extent of potential movement corridors and refuge areas.
- The number of threatened species known or with the potential to occur.

The fauna habitat attributes for each of the identified vegetation communities are discussed below.

Vegetation Community 3 – Paperbark Swamp Forest

Within Lot 1 DP 624217 this community is considered to exhibit medium fauna habitat values. Negative attributes lowering the habitat values include the presence of lantana, low density of hollow-bearing trees, low abundance of fallen timber and large edge effect for the vegetation remnant (eg weed invasion). Positive contributors to habitat include the presence of native plant species in all stratum, with the tree canopy largely intact and consistent with natural conditions. These conditions combined with the tree species of this vegetation provides an important autumn/winter foraging resource for birds and flying-foxes.

The combination of these habitat elements means that the vegetation is unlikely to support the entire range of fauna species that may typically be associated with this habitat type. Species that occupy edge environments are likely to be more common. Site observations, including repeated observations of the magpie, magpie-lark, noisy friarbird and grey butcherbird, are consistent with these habitat values. Species particularly those reliant upon a dense groundcover layer for protection and foraging purposes were absent.

Vegetation Community 5 – Swamp Oak Forest

This community has no hollow-bearing trees and generally little fallen timber. The linear orientation of the remnant exposes the vegetation to increased edge effects from adjoining vegetation communities, this being the exotic grassland, which when combined with grazing activity has resulted in a structurally simplified exotic understorey. None of the patches of this community lie within mapped key habitat or corridor areas.

The small stand at the southern end of the study area is ranked as low quality fauna habitat. The understorey has been cleared by long term grazing and the community has been reduced to remnant trees along the drainage line. While the bushland that lies to the west of this patch is connected, it remains relatively isolated due to its long linear shape and shared boundary with exotic grassland. This area would have once provided habitat for some birds, reptiles and frogs however is now only valued as a connected tree canopy.

Vegetation Community 6 – Freshwater Wetland

All occurrences of this community are ranked as medium to high value fauna habitat. The wetland observed in Lot 1 DP 624217 is connected with flooding processes of the Wilson River and alluvial groundwater conditions and as such has retained the core ecological functions that support the establishment of these communities. This community provides habitat for waterbirds, frogs and other wetland species, including occasional shelter or foraging habitat for some migratory bird species. Most of the patches are in reasonable condition, however all are subject to some level of disturbance as they lie within cleared or partially cleared pasture land and are grazed and therefore trampled by stock. Weeds and exotic pasture grasses are prevalent in some areas.

Vegetation Community 7 – Moist Floodplain Forest

This community occurs within the study area at Stumpy Creek, where it forms part of a mapped key habitat and corridor area along Cooperabung Drive. The Stumpy Creek patch is ranked as having high habitat value due to its connections with other native vegetation, presence of tree-hollows and fallen timber, low presence of weeds, high presence of native plant species and intact vegetation structure. However, the Cooperabung Drive patch occurs almost exclusively within disturbed

roadside environments where the small patch areas and presence of existing impact regimes from road usage and adjoining land uses make for a low habitat quality ranking

The presence of hollow bearing trees at Stumpy Creek is a key component of the high habitat quality ranking as this feature supports important lifecycle processes for hollow-reliant fauna (including many birds, arboreal mammals, insectivorous bats and some reptiles and frogs). The vegetation is not fragmented, thus further enhancing the habitat values of this vegetation patch.

The small patches ranked as low quality fauna habitat that lie along Cooperabung Road would primarily function as movement pathways for local fauna between better quality habitat areas. Only few species are capable of utilising the roadside environments characterised this vegetation community by local fauna populations due to the extent of disturbance by weeds on floristic integrity and roadside management practices on vegetation structure. Only small bird species (eg. wrens) and small sedentary reptiles (eg sunskinks) are likely to be encountered on a regular basis within these roadside environments.

Vegetation Community 8 – Moist Gully Forest

Much of this community has been ranked as high quality fauna habitat with most of the area identified as this community occurring at Stumpy Creek. These areas tend to contain good numbers of large mature trees, including those with hollows. The native canopy, shrub and ground layer are in good condition and weed invasion is minimal. Most of the good quality patches of this community lie within mapped key habitat and corridor areas attributed to the Maria River State Forest.

Isolated medium quality areas occur within the Cooperabung Drive road reserve. These areas tend to be more isolated from larger areas of intact habitat and have experienced greater levels of disturbance from road usage and adjoining agricultural land uses. The vegetation tends to be in low to moderate condition due to edge effects, with the absence of large mature trees and disrupted irregular vegetation linkages further compounding the negative edge effects of roadside environments on fauna habitat values.

Vegetation Community 10 – Dry Ridgetop Forest

This community is mostly located in mapped key habitat and corridor areas such as Stumpy Creek and Ravenswood Road. The patch observed at Stumpy Creek contains medium to good quality fauna habitat. Few weeds occur within this community at this location and these are mainly restricted to disturbed and edge areas. Most of this community has been subject to past logging, with the medium quality patches generally having been more recently logged while the good quality patches have had more time to recover.

Dry ridgetop forest in the study area provides habitat for fauna that prefer drier habitats and a more open understorey, as the shrub layer is generally sparse. At Stumpy Creek the vegetation is dominated by an understorey of *Allocasuarina littoralis*, and this is particularly important for the glossy-black cockatoo. The high quality fauna habitat found at Stumpy Creek is owing to the higher number of hollow-bearing trees, providing roosting and breeding habitat for a range of hollow-reliant fauna. Those patches dominated by spotted gum and ironbark would represent an important winter foraging resource for birds and flying-foxes. The medium quality habitat values of Ravenswood Road, Rodeo Drive and Cooperabung Drive is owing to the absence of tree-hollows within the road reserve and increased weed cover, with the latter having a negative influence on native species presence.

Vegetation Communities 13 – Totally Cleared / Open Pasture / Weedy Fallow

None of these communities have any areas ranked as high quality fauna habitat. They are ranked as low quality as they have been substantially cleared or modified and provide little in the way of natural fauna habitat. While some of these patches lie within mapped key habitat and corridor areas, they generally represent gaps in the tree cover rather than vegetated linkages between any areas of habitat.

The floodplains of the Hastings and Wilson rivers were difficult to rank as, although they have been cleared and consist of grazing lands dominated by introduced pasture grasses, they do provide habitat for native wet grassland/floodplain species, including frogs and some migratory wetland birds. This is relevant to Lot 1 DP 624217. Other patches of these communities contain scattered trees and while ranked as low quality fauna habitat, they still represent a foraging resource and occasional hollow-bearing trees provide roosting and breeding habitat for a number of hollow-reliant species.

3.6.3 Key habitats and regional corridors

Mapped key habitats in the study area comprise areas of predicted high conservation value for forest fauna, and include large areas of vegetated lands and important vegetation remnants (NPWS 2005). The connecting framework of regional and subregional corridors facilitates important ecological processes such as migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat (NPWS 2005).

Habitats to the east and west of the study area are fragmented by the existing highway, other roads and tracks, and clearing for agricultural activities. Notwithstanding, the study area overlaps two important habitat corridors including the Ballengarra – Maria River regional habitat corridor and Maria Link regional habitat corridor. These vegetation linkages form part of a framework of regional and subregional corridors which provide connectivity between key habitat areas as defined and mapped by the NPWS Key Habitats and Corridors in North East NSW Mapping Project (NPWS 2005, Scotts 2003). Mapping showing the outline of these corridors is provided in the Flora and Fauna Working Paper (GHD 2010a).

The Maria Link regional habitat corridor passes through Lot 80 DP 737375 (Stumpy Creek). This is a link between Maria National Park and Kumbatine National Park. The Ballangarra- Maria River regional corridor intersects Ravenswood Road and is a link between Smiths Creek and Knailers Road. These corridors are important for the movement of native fauna across the landscape. The Lower North Coast fauna assemblages known as ‘dry valleys’, ‘moist escarpment foothills’ and ‘dry coastal foothills’ have been identified as users of these corridors (NPWS 2005, Scotts 2003), with the koala, large forest owls and spotted-tailed quoll being prominent amongst these groups.

3.6.4 Critical habitat

No areas of critical habitat declared on the Registers of Critical Habitat kept by the Director-General of the DECCW, SEWPAC, or DII occur in the additional study area.

3.6.5 Overall terrestrial habitat values

Overall the study locality is considered to have high habitat value (GHD 2010a). Within the additional survey locations the quality of fauna habitat varies from very good in areas of relatively undisturbed vegetation that occur within Lot 80 737375 to poor in areas of cleared and degraded vegetation that occurs within parts of Lot 1 DP 624217 and sections of road reserve along Ravenswood Road, Cooperabung Drive and Rodeo Drive.

Notwithstanding the degraded nature of Lot 1 DP 624217 and sections of road reserve along Ravenswood Road, Cooperabung Drive and Rodeo Drive, parts of these sites have important ecological values such as their function in regional wildlife corridors (Ravenswood Road), habitat for the koala (Ravenswood Road, Rodeo Drive and Cooperabung Drive) and presence of EECs (Lot 1 DP 624217). This is in addition to general potential foraging habitat values for numerous threatened fauna species observed or likely to occur within the study locality.

3.7 Fauna assemblages

Mammals

Thirty native mammal species were recorded within the study area or adjoining habitats during the fauna field survey (**Appendix F**). They comprised three arboreal species, three macropods, 17 microchiropteran bat species, six ground-dwelling species and one flying-fox species.

Arboreal mammals, such as the sugar glider (*Petaurus breviceps*) and common brushtail possum (*Trichosurus vulpecular*) were primarily observed in the Cooperabung Drive and Rodeo Drive road reserves. Sugar gliders feed on the gum of acacia, the sap of eucalypts, invertebrates and invertebrate exudates, dependent on seasonal availability and are often locally common in forested habitats that provide hollows for shelter and foraging resources (Strahan 1995). Common brushtail and common ringtail possums (*Pseudocheirus peregrinus*) have a diverse diet of leaves, flowers, fruits and buds and are common and widespread throughout a wide variety of natural, rural and urban areas of south-eastern NSW (Strahan 1995).

Three macropod species, the swamp wallaby (*Wallabia bicolor*), red-necked wallaby (*Macropus rufogriseus*) and eastern grey kangaroo (*M. giganteus*), were recorded within the study area. Macropods were recorded in all habitat types along the study area either by scats or sightings.

The echidna (*Tachyglossus aculeatus*) was recorded from tracks near ant mound diggings within the study area. This species is likely to occur in forest and woodland/grassland ecotone areas throughout the study area and on adjoining lands. Evidence of the northern brown bandicoot (*Isoodon macrourus*) and long-nosed bandicoot (*Perameles nasuta*) was noted at Stumpy Creek. The northern brown bandicoot was identified by large open rounded diggings whilst the more narrow conical diggings were consistent with those of the long-nosed bandicoot. The brown antechinus (*Antechinus stuartii*), dusky antechinus (*Antechinus swainsonii*) and bush rat (*Rattus fuscipes*) are common ground-dwelling mammals recorded from the Elliott A ground traps at Stumpy Creek.

No sightings of the threatened yellow-bellied glider (*Petaurus australis*) or koala (*Phascolarctos cinereus)* were noted during the survey period despite prior records in the area. Most of the study area, with the exception of Lot 1 DP 624217, provides potential habitat for these species.

Microchiropteran bats

A diverse range of microchiropteran bat species were recorded during the field investigations (**Appendix F**). All of the microchiropteran bats recorded are insect-eating, catching insects on the wing or gleaning them from foliage or in some instances from the ground (Churchill 1998). Foraging behaviour varies among species and may be concentrated above, below or within the tree canopy, along the edges of vegetation and cleared land, or over open grassland areas. The species recorded are likely to forage widely throughout the study area and surrounding locality.

Five threatened microchiropteran bat species, the eastern false pipistrelle (*Falsistrellus tasmaniensis*), little bent-wing bat (*Miniopterus australis*), eastern bent-wing bat (*Miniopterus schreibersii*), eastern free-tail bat (*Mormopterus norfolkensis*) and hoary wattled bat (*Chalilinolobus nigrogriseus*) were recorded during the fauna field surveys. The greater broad-nosed bat (*Scoteanax rueppellii*) was also given a probable identification based on ultrasonic call analysis.

Of those recorded, three species (eastern horseshoe bat, little bent-wing bat and eastern bent-wing bat) rely on caves or similar artificial structures (such as mines and culverts) for roosting. There was an abundance of little bent-wing bat recordings particularly around Stumpy Creek, with many of these recordings evenly distributed throughout the night. This potentially indicates the presence of a roost site nearby, however, no recordings were attributed to the bridge structure at Stumpy Creek. Also recorded at Stumpy Creek was the hoary wattled bat, with only few recordings noted midway through the night. The low number and timing of recordings suggests that this species roosts elsewhere and uses Stumpy Creek as an area of foraging habitat.

Recordings of the eastern freetail bat, eastern bent-wing bat, eastern false pipistrelle and greater broad-nosed bat are almost entirely restricted to the Cooperabung Drive site. Given the absence of roost habitat for these species within the road reserve it is considered that these species are using the Cooperabung Drive vegetation as foraging habitat only. Potential roost locations are likely within the surrounding state forests and nature reserves.

Reptiles

A total of three reptile species were recorded during field surveys (**Appendix F**). The grass skink (*Lampropholis delicata*) was the most common reptile species and was recorded throughout the study area. No threatened reptile species were recorded.

The vegetation of Stumpy Creek contains areas of dense leaf litter and fallen logs, providing excellent foraging and refuge habitat for a range of reptile species. This is where the generalist lace monitor (*Varanus varius*) was observed. The eastern water dragon (*Physignathus lesueurii*) was observed at Cooperabung Creek prior to it making a rapid dash into the permanent water pool located beneath the bridge.

Frogs

A total of eight frog species were recorded during specific frog searches, evening spotlighting surveys or opportunistically within the study area (**Appendix F**). The most common frog species recorded were the common eastern toadlet (*Crinia signifera*), striped marsh frog (*Limnodynastes peroni*), red-backed toadlet (*Pseudophryne coriacea*) and eastern dwarf tree frog (*Litoria fallax*).

Potential habitat for frogs within the study area includes man-made dams, low-lying swamp forests, watercourses and roadside drainage lines. Watercourses consist of permanent streams, as well as ephemeral drainage lines providing suitable frog habitat in wetter periods. No threatened frog species were recorded within the study area however habitat for the giant barred frog (*Mixophyes iteratus*) and green-thighed frog (*Litoria brevipalmata*) occurs at the Stumpy Creek site.

Birds

The study area provides habitat for a relatively diverse array of shrubland, woodland and open forest bird species. A total of 121 species were recorded comprising 119 native and two introduced species (**Appendix F**). Seven bird species listed as threatened on the TSC Act were recorded in the prior survey: the black-necked stork (*Ephippiorhynchus asiaticus*), osprey (*Pandion haliaetus*), square-tailed kite (*Lophoictinia isura*), sooty owl (*Tyto tenebricosa*), glossy black-cockatoo (*Calyptorhynchus lathami)*, masked owl (*Tyto novaehollandiae*), and rose-crowned fruit-dove (*Ptilinopus regina)*. None of these species or any additional threatened birds were encountered during this field survey.

Nectar-eating species included a diverse assemblage of honeyeaters, miners, rosellas and lorikeets. Common insect-eating species included thornbills, pardalotes, robins, scrubwrens, tree-creepers and fairy-wrens. Seed-eating parrots and finches (such as rosellas and the red-browed finch (*Emblema temporalis*)) were also commonly recorded foraging in open grassland areas and in fringing woodland/grassland ecotone areas.

The whistling kite (*Haliastur indus*) and Australian hobby (*Falco longipennis*) were recorded, either perched in trees and on stags or foraging overhead in the study area. The fragmented nature of the vegetation in the study area is of particular relevance for these species as they utilise open grassland areas for foraging, and nearby forest and woodland habitat for roosting and nesting.

Nocturnal birds recorded in the study area were restricted to the tawny frogmouth (*Podargus strigoides*). The tawny frogmouth is a common and widespread species that occurs throughout a range of natural and modified environments and utilise open vantage points to watch for prey. As previously mentioned no threatened bird species were observed, however, high value habitat for the threatened sooty owl and masked owl is present at Stumpy Creek. Other parts of the study area providing suitable foraging habitat for these threatened owl species and the powerful owl (*Ninox strenua*). Owls occupy large home ranges and are likely to forage widely through woodland and forest habitats in the locality.

Only a small number of waterbirds were recorded in the study area. The low species diversity may be due to the relatively small area of aquatic and riparian habitats contained within the study area. Most of the waterbird species recorded during the field surveys are common species such as the Australian wood duck (*Chenonetta jubata)* and pacific black duck (*Anas superciliosa*), these normally found in a diverse spectrum of aquatic habitats.

3.8 Threatened terrestrial fauna

3.8.1 Vertebrate fauna

Interrogation of relevant wildlife databases and the literature review identified 84 threatened fauna species listed under the TSC Act that have been recorded or have potential to occur in the study locality. This comprises 46 bird, 28 mammal, two reptile, six amphibian and two invertebrate species (**Appendix A**), and includes an additional 15 species that were not identified in database searches undertaken for the Working Paper (GHD 2010a).

A total of 39 threatened fauna species and 36 migratory species listed under the EPBC Act are predicted to occur within the study locality (**Appendix B**). An additional three species were identified by the recent search of the EPBC Act protected matters database, including the New Holland mouse (*Pseudomys novaehollandiase*), hawksbill turtle (*Eretmochelys imbricata*) and flatback turtle (*Natator depressus*), with none of these species considered relevant to the study area due to an absence of potential habitat.

A total of 26 of the threatened fauna species are either marine mammals, reptiles, fish or pelagic birds, which are not relevant to the Proposal. Of the migratory species, 33 are associated with marine environments and are also not relevant to the Proposal.

One endangered population listed under the TSC Act (The Emu *Dromaius novaehollandiae* population in the North Coast Bioregion and Port Stephens LGA) was identified through the desktop review as potentially occurring within the study locality. There are, however, no records of emus within the study locality and it is therefore unlikely that the Proposal would affect this population.

An assessment of the potential for these threatened fauna and migratory species to occur within the study area was undertaken based on habitat preferences and habitat availability. This is provided in **Appendix F**.

Of the species previously recorded or potentially occurring in the locality, 46 threatened species were assessed as likely to occur within the study area based on known records and habitat availability, as detailed in **Table 3-4**. Seven of these 46 threatened species were recorded in the study area during the current field investigations. These are identified in bold in the following table. Only one threatened species that had not previously been recorded (hoary wattled bat) was identified within the study area (at Stumpy Creek) during the current targeted surveys.

Table 3-4 Threatened fauna species recorded during prior field surveys or considered likely to occur in the study area

Common name	Scientific name	TSC Act	EPBC Act
Species recorded during field surveys			
Black-necked stork	*Ephippiorhynchus asiaticus*	Endangered	
Eastern bent-wing bat	***Miniopterus schriebersii oceanensis***	**Vulnerable**	
Eastern false pipestrelle	***Falsistrellus tasmaniensis***	**Vulnerable**	

Common name	Scientific name	TSC Act	EPBC Act
Eastern freetail-bat (previously east-coast freetail-bat)	***Micronomus norfolkensis* (previously *Mormopterus norfolkensis*)**	**Vulnerable**	
Giant barred frog	*Mixophyes iteratus*	Endangered	Endangered
Glossy black-cockatoo	*Calyptorhynchus lathami*	Vulnerable	
Greater broad-nosed bat (probable)	***Scoteanax rueppellii***	**Vulnerable**	
Green-thighed frog	*Litoria brevipalmata*	Vulnerable	
Grey-headed flying-fox	***Pteropus poliocephalus***	**Vulnerable**	**Vulnerable**
Hoary wattled bat	***Chalinolobus nigrogriseus***	**Vulnerable**	
Koala	*Phascolarctos cinereus*	Vulnerable	
Little bent-wing bat	***Miniopterus australis***	**Vulnerable**	
Masked owl	*Tyto novaehollandiae*	Vulnerable	
Osprey	*Pandion haliaetus*	Vulnerable	Migratory
Rose-crowned fruit-dove	*Ptilinopus regina*	Vulnerable	
Sooty owl	*Tyto tenebricosa*	Vulnerable	
Southern myotis	*Myotis macropus*	Vulnerable	
Square-tailed kite	*Lophoictinia isura*	Vulnerable	
Yellow-bellied glider	*Petaurus australis*	Vulnerable	
Species considered highly likely to occur in the study area			
Brush-tailed phascogale	*Phascogale tapoatafa*	Vulnerable	
Common planigale	*Planigale maculata*	Vulnerable	
Powerful owl	*Ninox strenua*	Vulnerable	
Spotted-tail quoll	*Dasyurus maculata*	Vulnerable	Endangered
Squirrel glider	*Petaurus norfolcensis*	Vulnerable	
Species that may potentially occur in the study area			
Australasian bittern	*Botaurus poicilioptilus*	Endangered	
Australian painted snipe	*Rostratula benghalensis*	Vulnerable	Vulnerable
Barking owl	*Ninox connivens*	Vulnerable	
Barred cuckoo-shrike	*Coracina lineata*	Vulnerable	
Black bittern	*Ixobrychus flavicollis*	Vulnerable	
Comb-crested jacana	*Irediparra gallinacea*	Vulnerable	
Eastern chestnut mouse	*Pseudomys gracilicaudatus*	Vulnerable	
Giant dragonfly	*Petalura gigantea*	Endangered	

Common name	Scientific name	TSC Act	EPBC Act
Golden-tipped bat	*Kerivoula papuensis*	Vulnerable	
Grass owl	*Tyto capensis*	Vulnerable	
Green and golden bell frog	*Litoria aurea*	Endangered	Vulnerable
Grey-crowned babbler	*Pomatostomas temporalis temporalis*	Vulnerable	
Large-eared pied bat	*Chalinolobus dwyeri*	Vulnerable	Vulnerable
Long-nosed potoroo	*Potorous tridactylus*	Vulnerable	Vulnerable
Pale-headed snake	*Hoplocephalus bitorquatus*	Vulnerable	
Regent honeyeater	*Anthochaera phrygia*	Critically Endangered	Endangered, Migratory
Stephen's banded snake	*Hoplocephalus stephensii*	Vulnerable	
Stuttering frog	*Mixophyes balbus*	Endangered	Vulnerable
Superb fruit-dove	*Ptilinopus superbus*	Vulnerable	
Swift parrot	*Lathamus discolor*	Endangered	Endangered, Migratory
Wallum froglet	*Crinia tinnula*	Vulnerable	
Wompoo fruit-dove	*Ptilinopus magnificus*	Vulnerable	
Yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	Vulnerable	

The locations of threatened fauna species recorded within the study area during prior and current surveys are shown in **Appendix A** and are discussed further in the Working Paper (GHD 2010a). Species recorded within the study area during previous and current surveys are discussed below.

Threatened species observed during additional surveys

Eastern bent-wing bat

This species was recorded at nine sites by Ecotone during the previous surveys and again by GHD during these supplementary surveys (GHD 2010a). Small numbers of this species may seasonally roost under bridge and culverts along the existing highway. Maternity roost caves for this species occur at Yessabah caves, west of Kempsey. This species is known to travel up to 20 kilometres at night to feed.

Eastern false pipistrelle, greater broad-nosed bat and eastern freetail bat

The eastern false pipistrelle, greater broad-nosed bat and eastern freetail bat were all recorded during the current surveys at one site near the southern end of Cooperabung Drive. The few recordings of these species indicate that activity in this area by this species is low. It is possible that individuals were moving through the road reserve along a perpendicularly oriented drainage line as part of their movements between preferred habitats.

Grey-headed flying-fox

The grey-headed flying-fox is considered a seasonal feeder in the study area from nearby roosting camps at Crescent Head and Port Macquarie. There are no known camps within the study area.

This species was observed during the current surveys within the Cooperabung Drive service road, feeding on the only flowering tree (*Eucalyptus siderophloia*). Further utilisation of all habitats within the study area is expected throughout the year in line with flowering events.

Hoary wattled bat

This species was recorded during the current surveys foraging at the Stumpy Creek site. The Anabat recordings were few and recorded during the middle of the night. The data suggests that the occurrence of this species within the study area is for foraging purposes only. However, this species is known to use tree hollow roosts and may potentially use the site for roost and breeding activity. Recent records of this species along the Kempsey to Eungai Pacific Highway upgrade confirm the presence of this species within the locality, which appears to coincide with the southern limit of distribution for this species.

Little bent-wing bat

This species was also recorded foraging throughout the entire study area during the current surveys, however notable intense foraging activity was recorded at Stumpy Creek and to a lesser extent Rodeo Drive. Recordings 15 minutes after dusk and within one hour of dawn suggest that the roost site for this species is located nearby the Stumpy Creek site. Known breeding caves for this species occur in the Yessabah and Willi Willi caves, west of Kempsey. This species is also known to travel up to 20 kilometres at night to feed.

Threatened species not observed during additional surveys

The following comments relate to threatened species that have the potential to occur within the study area but were not recorded during the survey period. These species were generally recorded during previous surveys.

Black-necked stork

Two black-necked storks were recorded flying over Stoney Creek Water Sports Park on the Wilson River floodplain during spring surveys in September 2006 (HWR 2006). This is in close proximity to Lot 1 DP 624217 where potential habitat for this species was identified. Habitats of moderate to high value occurring within this part of the study area are not likely to be impacted by the Proposal (for example, freshwater wetlands).

Giant barred frog

This species was recorded during previous surveys at the Maria River crossing south of the Stumpy Creek site in prior surveys for this Proposal (GHD 2010a). It is likely that this species occurs at other locations within the locality especially within riparian habitats that are connected to the Maria River. Surveys at Stumpy Creek during the current field investigations failed to identify the presence of this species within the study area. The potential habitat contained at this location is considered to be of moderate value for this species.

Glossy black-cockatoo

Two preferred feed tree species for glossy black-cockatoos, including black she-oak (*Allocasuarina littoralis)* and forest oak (*Allocasuarina torulosa)*, occur in the study area and are common within the dry ridgetop forest community of Stumpy Creek. Glossy black-cockatoos have been seen feeding in black she-oak within the alignment and may use this area as part of a larger home range. No evidence of feeding activity was identified at the largest stand of *Allocasuarina* spp. encountered during this recent survey at Stumpy Creek.

Green-thighed frog

A population of green-thighed frogs has been recorded at Rawdon Creek Nature Reserve and Maria River State Forest in prior surveys. From the habitat analysis the indications are that the habitats immediately surrounding the Stumpy Creek riparian corridor are suitable for this species. These habitats include small closed depressions within the flood liable parts of Stumpy Creek. Local records from the Maria River support this view.

Koala

No koala activity was observed within the study area. However, the majority of the roadside environment at Rodeo Drive, Ravenswood Road and Cooperabung Drive represents potential koala habitat. Anecdotal records of koala usage within these service roads were also noted from conversations with adjoining property owners. Potential koala habitat located at Ravenswood Road is part of a regional wildlife corridor that could be utilised by the koala.

Masked owl

The masked owl was recorded during spring surveys in September 2006 as road kill at Telegraph Point, just south of the Wilson River. This species is considered particularly vulnerable to vehicle strikes as its preferred foraging habitat occurs along forest edges and into cleared habitats, such as roads, taking prey from the ground.

A separate field survey conducted to the north of Stumpy Creek (GHD 2010c) identified the masked owl within habitat contiguous with the study area. Foraging resources, including arboreal and ground mammals, are present within this area as are potential roost sites (large hollow bearing trees).

Osprey

Two individuals of this species were recorded flying over forest just north of Hastings River in November 2005 and 2007. The Hastings River is a known area of activity for this species where it is known to successfully breed at perennial nesting sites near Limeburners Nature Reserve. The utilisation of terrestrial habitats near the Hastings River by this species for nesting purposes is based on its requirements to access its main dietary needs (fish). An increased separation of nesting/breeding sites from foraging habitat would increase energy demand (movement to and from foraging habitat), which may adversely impact breeding success.

Spotted-tailed quoll

The spotted-tailed quoll has been recorded within the study locality but was not detected during previous or current surveys. Anecdotal records of this species have been noted during conversations with local property owners at Cooperabung Drive and Rodeo Drive. Specimens identified from road mortalities have also been noted in the study locality, notably near Cooperabung Drive, adding further evidence to the possibility that this species utilises parts of the study area.

This species is noted to occupy large home ranges, particularly males. These ranges are established through ongoing local movements following successful breeding activity. Localised migrations combined with intra home range foraging activity expose this species to increased risk of vehicle strike.

Sooty owl

The sooty owl was recorded in prior surveys for the Proposal near the Maria River. A single bird was recorded responding to call playback at this location, however, was not identified as occurring within the study area. This species has the potential to occur within the study area due to the similarity in habitat values between the study area and nearby observed locations at Maria River. This species is considered vulnerable to vehicle strike due to its high mobility and utilisation of variable habitats including cleared lands such as road corridors that adjoin preferred habitat areas.

3.8.2 Invertebrate fauna

One threatened invertebrate, the giant dragonfly (*Petalura gigantea*), has been previously recorded in the locality. This species is listed as endangered under the TSC Act and is threatened by declining population size and loss or degradation of wetland habitats.

The giant dragonfly has been recorded from both coastal and upland permanent wetlands from Moss Vale to southern Queensland, but has not been recorded in most areas for many years. Currently, the largest and most viable population is believed to occur in sphagnum swamp areas within Wingecarribee Swamp near Moss Vale. Only one record exists from within the locality of the study area (DECCW Wildlife Atlas). However, the paucity of records for the giant dragonfly in the locality may be more a reflection of the generally low likelihood of encountering individuals given their prolonged underground larval stage (10 to 20 years) and relatively short conspicuous adult phase, rather than an accurate indication of its presence in the locality.

The giant dragonfly was not specifically targeted during current field surveys though habitat assessments identified suitable potential habitat in swampy areas that occur within Lot 1 DP 624217.

According to the EPBC Act Protected Matters Search Tool, potential habitat may also exist within the study area for the laced fritillary (*Argyreus hyperbius*).The laced fritillary has an extremely localised distribution with populations restricted to open swampy coastal areas where the larval food plant (*Viola betonicifolia*) grows. It occurs from just south of Gympie, Queensland, to just north of Port Macquarie. *Viola betonicifolia* occurs within the study area at Stumpy Creek, however, its abundance is limited. No herbivory was noted on specimens observed at that location. The potential usage of this site by this species is considered low.

3.9 Migratory species

Of the 36 migratory species listed under the EPBC Act predicted to occur within the study locality, 15 species were either recorded or assessed as having some potential to occur within the study area based on known records and habitat availability within the study area.

Two migratory species, the satin flycatcher and Latham's Snipe, were recorded within the study area during the survey period. An additional six species have been recorded within the study locality during prior surveys (GHD 2010a) although these were not observed during the current surveys. These were the black-faced monarch, cattle egret, osprey, rufous fantail, white-bellied sea-eagle and white-throated needletail. The EPBC Act Protected Matters Search Tool identified seven additional migratory species that have potential to occur within the study locality, the Australian painted snipe, fork-tailed swift, great egret, rainbow bee-eater, regent honeyeater, spectacled monarch and swift parrot. Further consideration of these matters is provided in **Appendix H**

3.10 Aquatic habitats

Stumpy Creek is a class 2 waterway which forms a chain of ponds separated by narrow runs and formed vegetated riffles. The creek ranges from 1 to 4 metres wide with an average depth of 0.5 metres. It is located within a small confined floodplain formed by narrow alluvial benches within a shallow valley. At the time of the survey, the creek water level was moderate, not flowing and fish passage was considered moderately restricted.

Either side of the road reserve of the existing Pacific Highway, stream banks were observed to be stable with no evidence of erosion and heavily vegetated dominated largely by spiny-headed mat rush providing overhanging structural habitat for fish (refer to Plate 14). The creek contained limited in-stream vegetation due to the channel shape preventing establishment of emergent vegetation within the creek. Some isolated patches of emergent vegetation were observed in shallower, sheltered areas where sediment has collected.

Plate 14 Stumpy Creek (downstream)

Along the majority of Stumpy Creek within the study area the riparian corridor remains largely intact due to native forest occurring upstream of the Pacific Highway and privately owned, uncleared lots of land, downstream of the Pacific Highway. The riparian vegetation is continuous along the creek line and extends approximately 25 metres either side of the creek from the northern and southern banks. The vegetation is in very good condition characterised by dense native species and low levels of weeds. This intact riparian corridor provides in-stream structural habitat components for fish with a continual input of stream organic matter and large woody debris.

Within the road reserve of the existing Pacific Highway under the northbound and southbound bridges, the riparian vegetation is no longer intact which has encouraged high levels of weeds, increased water temperatures, sedimentation, filamentous algae and severe bank erosion (refer to Plate 15). Due to sedimentation and modification of the stream channel, a higher level of emergent vegetation was present in comparison to the upstream and downstream sites.

Plate 15 Stumpy Creek (Site 2 east of southbound bridge)

The water within Stumpy Creek was generally slightly tannic with a low turbidity ranging 2.5 to 25.6 NTU and pH levels were acidic, ranging between 5.4 to 5.8. The electrical conductivity was low ranging between 90.6 to 136.2 microsiemens per centimetre. Generally, Stumpy Creek recorded a very low dissolved oxygen content averaging 21 per cent saturation. This is likely due to little to no in-stream vegetation, no flows and high levels of organic matter accumulation and decomposition rates.

When compared with ANZECC trigger values for freshwater lowland rivers in southeast Australia, the water quality variables for Stumpy Creek for electrical conductivity, dissolved oxygen and pH level are generally below (do not meet the bottom range level) the ANZECC trigger value range.

3.10.1 Habitat assessment results

Site 1 (upstream)

Situated approximately 40 metres upstream of the existing Pacific Highway northbound bridge crossing, Site 1 was located in a small floodplain within a shallow valley. The watercourse consisted of a run (100 per cent) bed form feature. The channel was box shaped with vertical banks approximately 1 metre to 1.5 metres wide and 0.5 metres to 1 metre deep. The water level was moderate and not flowing, with a biological sheen present at the time of assessment and fish passage was considered moderately restricted.

The site was devoid of any in-stream aquatic vegetation (macrophytes) and approximately 3 per cent cover of large woody debris was observed. There were a limited number of snags and large woody debris to provide structural in-stream habitat for fish. Stream banks were stable with no evidence of erosion observed and were heavily vegetated, dominated largely by spiny-headed mat rush providing overhanging structural habitat for fish. Trailing bank vegetation presence was considered extensive.

The substratum was characterised by low compacted, fine grained sediments (more than 60 per cent) with cobble, pebble and gravel fractions not present. Sediments were largely anoxic likely due to the presence of high levels of organic matter accumulation, high decomposition rates and no flow.

Local land use (facing downstream) was native forest adjacent to both banks. The site has been impacted by the removal of vegetation, allowing the invasion of exotic vegetation and associated erosion processes occurring on unvegetated banks, due to the construction of the existing Pacific Highway crossing.

Site 2 (downstream of Pacific Highway southbound bridge)

Located directly to the east (downstream) of the existing Pacific Highway southbound bridge crossing, Site 2 was located within a shallow valley. The watercourse consisted of a pool (100 per cent) bed form feature. The channel was U-shaped with steep banks and was approximately 3 metres to 4 metres wide and 0.5 metres deep.

The water level was moderate and not flowing, with a biological sheen present at the time of assessment and fish passage was considered moderately restricted. The water was moderately turbid.

The channel contained isolated patches of emergent aquatic vegetation (7 per cent cover) with approximately 2 per cent cover of submerged filamentous algae and 1 per cent cover of large woody debris. There were a limited number of snags to provide structural in-stream habitat for fish. Stream banks were sparsely vegetated and unstable with evidence of erosion observed. Trailing bank vegetation presence was slight.

The substratum was characterised by low compacted, fine grained sediments (greater than 60 per cent) with cobble, pebble and gravel fractions not present. No sediment odours were observed. Local land use (facing downstream) was native forest adjacent to both banks.

The site has been impacted by the construction of the existing Pacific Highway crossing and private access tracks within 5 metres of the watercourse, both resulting in significant disturbance creek banks and the invasion of exotic vegetation.

Site 3 (downstream)

Situated approximately 150 metres downstream of the existing Pacific Highway southbound bridge crossing, Site 3 was located in a small confined floodplain within a shallow valley. The watercourse consisted of pool (90 per cent) and narrow run (10 per cent) bed form features. The channel was a wide box shape with vertical banks and was approximately 2 metres to 3 metres wide and 0.7 metres to 1 metre deep. The water level was moderate and not flowing, with a biological sheen present at the time of assessment and fish passage was considered moderately restricted.

The site was devoid of any in-stream aquatic vegetation (macrophytes) and approximately 10 per cent cover of large woody debris was observed. A small number of snags and large woody debris were present providing limited in-stream structural habitat components for fish. Stream banks were stable with no evidence of erosion observed and were heavily vegetated dominated largely by spiny-headed mat rush providing overhanging structural habitat for fish. Trailing bank vegetation presence was considered extensive.

The substratum was characterised by low compacted, fine grained sediments (more than 60 per cent) with cobble, pebble and gravel fractions not present. Sediments were largely anoxic likely due to the presence of high levels of organic matter accumulation, high decomposition rates and no flow.

Local land use (facing downstream) was native forest adjacent to both banks. The site has been impacted by the moderate invasion of exotic vegetation.

Site 4 (downstream)

Situated approximately 250 metres downstream of the existing Pacific Highway southbound bridge crossing, Site 3 was located in a small confined floodplain within a shallow valley. The watercourse consisted of pool (90 per cent) and narrow run (10 per cent) bed form features. The channel was a wide box shape with vertical banks approximately and 2 metres to 3 metres wide and 0.7 metres to 1 metre deep. The water level was moderate and not flowing, with a biological sheen present at the time of assessment and fish passage was considered moderately restricted.

The site was devoid of any in-stream aquatic vegetation (macrophytes). Approximately 20 per cent cover of large woody debris was observed providing in-stream structural habitat components for fish. Stream banks were stable with no evidence of erosion observed and were heavily vegetated dominated largely by spiny-headed mat rush providing overhanging structural habitat for fish. Trailing bank vegetation presence was considered extensive.

The substratum was characterised by low compacted, fine grained sediments (greater than 60 per cent) with cobble, pebble and gravel fractions not present. Sediments were largely anoxic likely due to the presence of high levels of organic matter accumulation, high decomposition rates and no flow.

Local land use (facing downstream) was native forest adjacent to both banks. The site has been impacted by the moderate invasion of exotic vegetation.

Water quality

The field water quality results were assessed with respect to the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC/ARMCANZ, 2000) trigger values for the protection of aquatic ecosystems at the 95 per cent level of protection. Site specific interactions between water, geology, flow regimes and vegetation all influence water quality parameters within individual creeks and as such, the ANZECC guidelines are simply a first point of reference for comparison of recorded values.

A comparison of the water quality results from Stumpy Creek against the ANZECC trigger values is shown in **Table 3-5**.

Table 3-5 Water quality results for Stumpy Creek

Site no.	Temperature (^{o}C)	pH	Turbidity (NTU)	Dissolved oxygen (%)	Electrical conductivity (µs/cm)
ANZECC (2000) trigger value	**No value**	**6.5-8.0**	**6-50**	**85-110**	**125-2200**
1	18.5	5.8	10.1	12	136.2
2	18.5	5.8	25.6	43	90.6
3	17.6	5.4	10.7	14	123.4
4	17.4	5.5	2.5	16	127.3

Site 1 (upstream)

The water within Stumpy Creek at this site was slightly tannic with a turbidity of 10.1 NTU and pH levels were acidic, with a value of 5.8. The electrical conductivity was low at 136.2 microsiemens per centimetre. Site 1 recorded a very low dissolved oxygen content of 12 per cent saturation. This is likely due to high levels of organic matter accumulation and decomposition rates and limited to no flows.

When compared with ANZECC trigger values for freshwater lowland rivers in southeast Australia, the water quality variables for electrical conductivity, dissolved oxygen and pH level at this site are below (do not meet the bottom range level) the ANZECC trigger value range.

Site 2 (downstream of Pacific Highway southbound bridge)

The water within Stumpy Creek at this site was turbid at 25.6 NTU and pH levels were acidic, with a value of 5.8. The slightly higher turbidity at this site is likely contributed to the low levels of bank vegetation and erosion at this site. The electrical conductivity was very low at 90.6 microsiemens per centimetre. Site 1 recorded a low dissolved oxygen content of 43 per cent saturation, slightly higher than the upstream and downstream sites.

When compared with ANZECC trigger values for freshwater lowland rivers in southeast Australia, the water quality variables for electrical conductivity, dissolved oxygen and pH level at this site are below (do not meet the bottom range level) the ANZECC trigger value range.

Site 3 (downstream)

The water within Stumpy Creek at this site was slightly tannic with a turbidity of 10.7 NTU and pH levels were acidic, with a value of 5.4. The electrical conductivity was low at 123.5 microsiemens per centimetre. There was a very low dissolved oxygen content of 14 per cent saturation. This is likely due to high levels of organic matter accumulation and decomposition rates and limited to no flows.

When compared with ANZECC trigger values for freshwater lowland rivers in southeast Australia, the water quality variables for electrical conductivity, dissolved oxygen and pH level at this site are below (do not meet the bottom range level) the ANZECC trigger value range.

Site 4 (downstream)

The water was slightly tannic with a very low turbidity of 2.5 NTU and pH levels were acidic, with a value of 5.5. The electrical conductivity was low at 127.5 microsiemens per centimetre. Site 1 recorded a very low dissolved oxygen content of 16 per cent saturation. This is likely due to high levels of organic matter accumulation and decomposition rates and limited to no flows.

When compared with ANZECC trigger values for freshwater lowland rivers in southeast Australia, the water quality variables for dissolved oxygen and pH level at this site are below (do not meet the bottom range level) the ANZECC trigger value range.

Stumpy Creek water quality overview

When compared with ANZECC trigger values for freshwater lowland rivers in southeast Australia, the water quality variables for Stumpy Creek for electrical conductivity, dissolved oxygen and pH level are generally below (do not meet the bottom range level) the ANZECC trigger value range.

Generally, Stumpy Creek recorded a very low dissolved oxygen content averaging 21 per cent saturation. This is likely due to little to no in-stream vegetation, no flows and high levels of organic

matter accumulation and decomposition rates. Low dissolved oxygen levels will affect the composition of aquatic organisms present within the creek, favouring species resilient to low dissolved oxygen concentrations.

3.10.2 Aquatic fauna

Fish survey results

A total of 51 individuals, representing three species from one family of fish, were recorded during the field surveys, none of which are threatened species. All three fish species recorded were native. No introduced/exotic species were encountered during the survey.

An aquatic fauna species list, and the site at which species were collected, is included in **Table 3-6**.

Table 3-6 Overall fish catch for Stumpy Creek

Scientific Name	Common Name	Collected at site			
		Upstream	Midstream	Downstream	Total
Gobiomorphus australis	Striped gudgeon	1	10	27	**38**
Hypseleotris compressa	Empire gudgeon	-	6	5	**11**
Hypseleotris galii	Firetail gudgeon	-	-	1	**1**
unknown	Juvenile gudgeon	-	-	1	**1**

The striped gudgeon sampled ranged in size from 25 millimetres to 100 millimetres, and accounted for 75 per cent of the total catch. Individuals were represented from all of the size classes with one juvenile gudgeon collected, indicating there is likely viable population within this system however a larger representation of fish would need to be collected to confirm this.

The empire gudgeon sampled ranged in size from 55 millimetres to 90 millimetres, and accounted for 22 per cent of the total catch. As only 11 specimens were collected, it is difficult to determine whether there is a viable population present in Stumpy Creek.

Only one firetail gudgeon was sampled at a size of 20 millimetres, which accounted for 2 per cent of the total catch. As only one specimen was collected, it is difficult to determine whether there is a viable population present in Stumpy Creek.

The fish species recorded are known to be resilient to low dissolved oxygen concentrations, possibly explaining the uniformity observed across sites. Aquatic organisms become stressed when concentrations of dissolved oxygen fall below 6 milligrams per litre or 80–90 per cent saturation over at least one 24 hour period (ANZECC 2000) and are likely to further become stressed through diurnal fluctuations of temperature. This is especially compounded in streams of an ephemeral nature, which at times are reduced to a series of isolated pools that are susceptible to stagnation and organic enrichment.

It is widely recognised that oxygen concentrations are a factor influencing the composition of freshwater communities because it critically affects the distribution of many species (Connolly *et al*. 2004). The absence of large predatory species such as Australian bass (*Macquaria novemaculeata*), estuary perch (*Macquaria colonorum*) and oxygen-sensitive foraging species such as Australian smelt (*Retropinna semoni*) and common jollytail (*Galaxius maculatus*) suggests that oxygen concentrations may be a significant factor determining the structure of the fish community within Stumpy Creek.

The results of the habitat assessment and water quality results for Stumpy Creek are described in **Section 3.10**

3.10.3 Threatened aquatic species

Threatened aquatic plants

A search of threatened aquatic plant records held by the DECCW Wildlife Atlas and threatened aquatic species profiles listed by DII, identified no records for threatened freshwater plants in the locality, only marine species that do not occur in the study area due to an absence of suitable marine habitat.

Threatened fish

No threatened fish species listed under the FM Act or the EPBC Act were recorded during surveys. A search of threatened and protected fish species records held by DII identified no threatened fish species previously recorded in the locality of the Proposal. An additional search of the Northern Rivers Catchment Management Area identified two threatened fish species, Oxleyan pygmy perch (*Nannoperca oxleyana)* and eastern freshwater cod (*Maccullochella ikei),* both listed as endangered under the FM Act and the EPBC Act. Neither of these species is considered likely to occur in the study area on the basis of their known distribution limits and an absence of suitable habitat as discussed below. Based on these considerations, no threatened fish species listed under the FM Act or the EPBC Act are considered likely to occur in the study area.

Oxleyan pygmy perch

No records of the Oxleyan pygmy perch were found in the DII Threatened Species Records View database for the study area. The study area is located beyond the southern limit of the currently known distribution of the Oxleyan pygmy perch north of Coffs Harbour (DII 2010). In NSW, Oxleyan pygmy perch have been recorded from 70 water bodies between the townships of Broadwater and Red Rock (DII 2010).

The Oxleyan pygmy perch occurs in coastal banksia-dominated heath or ‘wallum’ habitats containing freshwater lakes, creeks and wetlands (Allen, Midgley and Allen 2003). The pH levels within these habitats usually range from 5.9 to 7.2 and the water tends to be organically stained (McDowall 1996). This species is generally restricted to waters of low conductivity (less than 330 microsiemens per centimetre) and low flow environments (less than 0.3 metres per second) (Knight 2000). The Oxleyan pygmy perch usually inhabits waters with a high proportion of aquatic plant cover, between 60 to 80 per cent (DPI, 2005). Plant cover usually consists of various aquatic macrophytes, including stands of emergent sedges *(Lepironia articulata, Gahnia sp.* and *Juncus* sp.), beds of submerged sedges (*Eleocharis ochrostachys*) and growths of *Nymphaea* sp., *Chara* sp. and *Utricularia* sp. (DPI, 2005). In northern NSW, the broad-leaved paperbark (*Melaleuca quinquenervia*) occurred at 80 per cent of the sites where the Oxleyan pygmy perch was present,

and assemblages of native riparian vegetation and aquatic macrophytes were found in association with the fish at many of the sites (Knight 2000).

The water quality parameters for Stumpy Creek share the common attributes of the chemical characteristics required for the Oxleyan pygmy perch habitats. However, the study found that Stumpy Creek lacks the stream structure and habitat critical for the presence of this species.

Given that the study area is located outside the known natural distribution of the Oxleyan pygmy perch and the absence of critical habitat elements, it is considered highly unlikely that Stumpy Creek provides potential habitat for this species.

Eastern freshwater cod

No records of the eastern freshwater cod were found in the DII Threatened Species Records View database for the study area. The study area is located beyond the southern limit of the currently known distribution of the eastern freshwater cod (NSW Fisheries 2004).

The aquatic habitat of Stumpy Creek did not contain the habitat requirements of the eastern freshwater cod. This species prefers clear rocky streams (McDowall 1996) and rivers with slow flow and an abundance of in-stream cover including rocks, timber or tussocks (Rowland 1996). Recent research indicates that it is associated with deeper parts of the river near cover, especially around rocky islands and large boulders in faster-flowing sections (NSW Fisheries 2004). As with related species, large woody debris may provide shelter and important spawning sites (NSW Fisheries 2004). Unfortunately, the habitat requirements of the various life history stages are largely unknown; however, it is likely that, as with similar species (*Maccullochella peelii*), seasonal fluctuations in water level and changes in water temperature act as environmental cues for spawning and migration (NSW Fisheries 2004).

Given that the study area is located outside the known natural distribution of the eastern freshwater cod and the absence of habitat elements, it is considered highly unlikely that Stumpy Creek provides potential habitat for this species.

3.11 Groundwater dependent ecological communities

Groundwater dependent ecological communities are communities which have their species composition and their natural ecological processes determined by groundwater. Ecosystems vary greatly in the degree of their dependency on groundwater, from having no apparent dependence through to be entirely dependent on it (Department of Land and Water Conservation 2002).

In the vicinity of the study area shallow alluvial groundwater systems are associated with the floodplains of the Hastings, Wilson and Maria rivers, with the Maria River also being associated with a coastal sand bed groundwater system outside the study area. Shallow alluvial groundwater systems of more restricted extent are also likely to be associated with smaller streams elsewhere within the study area.

The Working Paper (GHD 2010a) defines the likely groundwater dependence for each vegetation community identified within the study area. The impacts of the Proposal on these vegetation communities are considered the same as those outlined in the Working Paper (GHD 2010a).

4. Impacts on biodiversity

4.1 Overview

The majority of the Proposal's impacts have been defined and discussed in the Environmental Assessment (GHD 2010b), and Working Paper (GHD 2010a), including issues such as:

- Loss of native vegetation including endangered ecological communities.
- Loss of species habitat including threatened flora and fauna populations.
- Habitat fragmentation.
- Barrier effects.
- Edge effects.
- Changed hydrological regimes and the impacts on water quality, fish habitat and passage.

These impact considerations are relevant to the study area and are the focus of this assessment.

The purpose of this assessment was to identify and examine any ecological impacts that are new or additional to those impacts already identified for the Proposal in the Working Paper (GHD 2010a) and Environmental Assessment (GHD 2010b).

4.2 Loss of native vegetation

In addition to the 203.1 hectares of native vegetation that would need to be cleared within the Proposal footprint (outlined in Section 4.2 of the Working Paper (GHD 2010a)), potential exists for the clearing of additional vegetation from within the study area at Stumpy Creek and the two private properties that were previously not accessible for survey.

Table 4-1 identifies the native vegetation clearing that is likely to occur within the study area, as identified in this survey, and the net change in the impacts when compared to those reported in the Environmental Assessment (GHD 2010b).

Table 4-1 Additional native vegetation clearance

Vegetation community	Impact area within study area (ha)	Net change in impact area for Proposal (ha)
Natural communities		
3 Paperbark Swamp Forest	1.7	+ 1.7
4 Swamp Mahogany / Forest Red Gum Swamp Forest	0	- 1.7
5 Swamp Oak Forest	0.8	0
6 Freshwater Wetland	0.1	0
7 Moist Floodplain Forest	1.2	+ 0.8
8 Moist Gully Forest	1.6	+ 1.6
10 Dry Ridgetop Forest	0.4	- 2.0
Total natural communities	***5.8***	***+ 0.4***

The increased impact on Paperbark Swamp Forest is mirrored by an equal impact reduction of Swamp Mahogany Forest/ Red Gum Swamp Forest. This net change is a consequence of a revised vegetation classification for Lot 1 DP 624217 that was not accessible in earlier field surveys.

There is no net change in relation to Swamp Oak Forest and Freshwater Wetland, as these communities were identified on the basis of visual inspection from outside the private properties during the previous surveys. The extent of vegetation removal associated with these communities was therefore included in the clearing estimates provided in the Environmental Assessment.

Other net changes are attributed to the revision of vegetation mapping classification at Stumpy Creek. Net changes at this site are attributed to new vegetation classifications based on detailed quadrat data and a northern extension to the area surveyed for the Proposal. The new 0.4 hectare area to the north was mapped as Dry Ridgetop Forest, which is an additional impact to that reported in the Environmental Assessment (GHD 2010b). Revised vegetation mapping resulted in an adjustment of prior mapped areas of Dry Ridgetop Forest to a combination of Moist Gully Forest and Moist Floodplain Forest.

Area calculations for vegetation clearing that may occur along the roadside environments of Ravenswood Road, Rodeo Drive and Cooperabung Drive have not been estimated in this report, as it is not yet known how much vegetation would be required to be removed. These roads have already been formed, and any increase in width would be designed to avoid or minimise impacts to native vegetation.

Descriptions and quantities of the four EECs that would be directly impacted within the original Proposal footprint to some degree are provided in Sections 3.7 and 4.2 of the Working Paper (GHD 2010a).

An assessment of the extent of impacts on EECs in a regional context is outlined in Section 4.15 of the Working Paper (GHD 2010a).

Of the native vegetation to be cleared by the Proposal within the study area, approximately 3.8 hectares qualifies as EECs listed under the TSC Act, as shown in **Table 4-2**. This table also identifies the net increase in impact to EECs, compared to that assessed in the Environmental Assessment.

The total area of native vegetation, including EECs, to be cleared does not include potential indirect impacts in areas of retained vegetation adjoining the Proposal footprint. Runoff of sediment, nutrients and pollutants could directly impact on the habitat of both ecological communities and threatened species during both the construction and operation phases of the Proposal. There is also the potential for modification of retained habitats as a result of edge effects, including the establishment of weeds.

While the proposed vegetation clearing is unlikely to result in the local extinction of any threatened flora or fauna species or EEC, the Proposal is considered likely to contribute to the cumulative effects of habitat loss affecting these species and EECs in the region. Refer to **Section 5**, **Appendix G** and **Appendix H** for assessments of significance of impacts on threatened species and EECs under Part 3A of the EP&A Act and the EPBC Act.

Table 4-2 Extent of impact on endangered ecological communities in the Proposal footprint

Endangered ecological community	Endangered ecological communities directly affected within the study area
Swamp Sclerophyll Forest Vegetation communities 3 and 4	1.7 ha (no net increase)
Swamp Oak Floodplain Forest Vegetation community 5	0.8 ha (no net increase)
Subtropical Coastal Floodplain Forest	1.2 ha (net increase of 0.8 ha)
Freshwater Wetlands Vegetation community 6	0.1 ha (no net increase)
Total	**3.8 ha (net increase of 0.8 ha)**

4.3 Loss of threatened plants

No threatened flora species were recorded within the study area during the terrestrial flora surveys as described in **Section 3.3**. However, as a precautionary measure an assessment of the possible impact of the Proposal on seven threatened flora species that may potentially occur in areas of suitable habitat within the Proposal footprint has been undertaken.

An assessment of the likely significance of impacts on these threatened plant species has been prepared for these species on a precautionary basis assuming them to be present and is presented in **Appendix G** and **Appendix H**. The results of the assessment are summarised in **Section 5**.

4.4 Loss of fauna habitat

Further to the loss of habitat detailed in **Section 4.4** of the Working Paper (GHD 2010a), the clearance of native vegetation within the study area would result in the loss of 5.8 hectares of habitat for fauna species, including areas of 'key habitat' associated with regional and subregional corridors mapped by the DECCW (NPWS 2005). This is a net increase in vegetation clearing of 0.4 hectares when compared to the estimates provided in the Environmental Assessment (GHD 2010b).

Table 4-3 shows threatened species known to occur or which may potentially occur in the habitat types that are to be cleared within the study area, and the extent of the clearing required.

Table 4-3 Potential fauna habitat loss

Vegetation community		Threatened fauna known or with potential to occur	Area impacted
Natural communities			
3	Paperbark Swamp Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, eastern chestnut mouse, owls, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider, wallum froglet.	1.7 ha
5	Swamp Oak Forest	Barred cuckoo-shrike, insectivorous bats, owls, koala, square-tailed kite.	0.8 ha
6	Wetland	Giant dragonfly, southern myotis, Australasian bittern, Australian painted snipe, black-necked stork, comb-crested jacana.	0.1 ha

Vegetation community		Threatened fauna known or with potential to occur	Area impacted
7	Moist Floodplain Forest	Insectivorous bats, common planigale, owls, glossy black-cockatoo, green-thighed frog, grey-crowned babbler, grey-headed flying-fox, koala, pale-headed snake, spotted-tailed quoll, square-tailed kite, squirrel glider, yellow-bellied glider.	1.2 ha
8	Moist Gully Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, owls, fruit-doves, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, pale-headed snake, spotted-tailed quoll, square-tailed kite, squirrel glider, Stephens' banded snake, yellow-bellied glider.	1.6 ha
9	Moist Slopes Forest	Brush-tailed phascogale, insectivorous bats, common planigale, owls, glossy black-cockatoo, green-thighed frog, grey-crowned babbler, grey-headed flying-fox, koala, pale-headed snake, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider, yellow-bellied glider.	Not determined (roadside vegetation along existing roads)
10	Dry Ridgetop Forest	Brush-tailed phascogale, insectivorous bats, owls, glossy black-cockatoo, grey-crowned babbler, grey-headed flying-fox, koala, pale-headed snake, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider.	0.4 ha
Total natural communities			***5.8 ha***
Artificial or highly modified communities			
11	Cleared – Scattered Trees	Potential occasional visits by grey-headed flying-fox, swift parrot, regent honeyeater and insectivorous bats. Some large trees may provide potential roost sites for insectivorous bats or a potential nest tree for the osprey. These areas may also provide a corridor link for some species, in particular the koala.	Unknown at this stage

Section 4.4 of the Working Paper (GHD 2010a) describes the potential impacts of the proposal on areas of 'potential' and 'core' koala habitat as defined under SEPP 44. In addition to these impacts areas within the additional study areas where 'core habitat' is likely to be lost or modified include in particular where natural vegetation occurs on either side of the road at the following locations: Cooperabung Drive, Rodeo Drive, Ravenswood Road and Lot 80 7373735.

It is unlikely that the Proposal would result in any additional impacts on breeding habitat for the green-thighed frog or giant barred frog.

4.5 Habitat fragmentation

Sections 4.5 and 6.2 of the Working Paper (GHD 2010a) describe the potential impacts of habitat fragmentation associated with the Proposal along with mitigation measures that have been incorporated into the Proposal design to reduce these impacts (for example, dedicated fauna underpasses, combined drainage / fauna movement culverts, aerial fauna crossings and glider poles in conjunction with wildlife exclusion fencing, bridge design to facilitate fauna movements along the banks of watercourses).

Works to be undertaken for the proposed service roads in the study area will involve the upgrade of existing roads and are consequently unlikely to result in any substantive additional impacts associated with habitat fragmentation. The potential for further habitat fragmentation at Stumpy Creek would be limited given the construction of the new alignment and bridge adjacent to the

existing highway. Proposed mitigation measures specific to the study area to maintain connectivity between stands of existing vegetation and fauna habitats and to facilitate fauna movements through the area are presented in **Section 6** of this report.

4.6 Barrier effects, road mortality and impacts on fauna movements and populations

Within the additional study areas, the Proposal traverses intact stands of vegetation comprising areas of key habitat that support high native species diversity and that contribute to regional wildlife corridors (NPWS 2005) likely to facilitate fauna movements through the landscape. As such, it has potential to exacerbate barrier impacts and road mortality for terrestrial fauna, such as the koala, spotted-tailed quoll and brush-tailed phascogale **(see Section 3.6.3**). There is the potential for an increase in fauna barrier impacts at Stumpy Creek where an additional alignment and bridge are proposed adjacent to the existing Highway. While no substantive widening of the proposed service roads is planned the Proposal is likely to result in increased traffic counts and vehicle speed along these roads. These changes could potentially lead to an increased risk of vehicle strike for fauna species such as the koala and spotted-tailed quoll.

The potential impacts of the Proposal on habitat connectivity for fauna groups and a selection of key threatened species of relevance to the study area are discussed in Section 4.6.1 of the Working Paper (GHD 2010a). Habitats and potential impacts of the Proposal in the study area are consistent with the broader Proposal assessed in the Working Paper. As such the prior assessment has been used as the basis for the Assessment of Impacts under the Part 3A threatened species assessment guidelines for the study area provided in **Appendix G**.

Mitigation measures incorporated into the Proposal design to reduce the impact of barrier effects and road mortality, including the construction of fauna crossings and wildlife exclusion fencing and the design of bridges to provide opportunities for fauna movements along the banks of watercourses are discussed in the Working Paper (GHD 2010a). Additional measures are also provided in **Section 6** of this report. Studies undertaken at other locations along the upgraded Pacific Highway (AMBS 2000-2002) have shown a wide range of fauna will use fauna underpasses of similar structure and dimensions to those proposed as part of the Proposal. On this basis, it is considered reasonable to assume that fauna in the study area will utilise such features to safely cross the new road if appropriately designed and placed in the landscape.

4.7 Edge effects

The potential edge effects associated with the Proposal are discussed in Section 4.8 of the Working Paper. The smaller more isolated fragments of vegetation and vegetation lining the existing Highway and other roads within the study area are already affected by edge effects to varying extents. Proposed works along service roads in the study area will not involve substantive widening and any incremental increase in edge effects in these areas would likely be negligible. The potential for adverse impacts in the study area as a result of edge effects would be greater at Stumpy Creek where the Proposal will traverse larger stands of vegetation within state forest. However, with the implementation of proposed mitigation measures, the potential for adverse impacts associated with edge effects would be minimised.

The range of impact mitigation measures to be implemented to minimise edge effects on retained native vegetation within the study area are discussed in Section 6.2 of the Working Paper. These include implementation of soil and sediment controls, progressive revegetation and rehabilitation of

disturbed areas not required for the operation of the road and the implementation of a weed control and management program.

4.8 Weeds and diseases

There is the potential for the introduction of weeds where the Proposal traverses intact stands of native vegetation. Construction also has the potential to introduce or spread root rot *Phytophthora cinnamomi*. Five weeds recorded within the study area are declared noxious under the *Noxious Weeds Act 1993*, including lantana, the most abundant and widespread weed in the study area. The 'invasion, establishment and spread of lantana' is listed as a key threatening process under the TSC Act.

Proposed measures for the management of weeds and root rot in the study area are described in Section 6.2 of the Working Paper. A weed management strategy would be developed, prior to commencement of construction that aims to prevent the spread of noxious and environmental weeds beyond roadside reserves and reduce their abundance within these areas during construction. Protocols that currently exist in relation to weed management for roads managed by the RTA would be applied for the operational phase of the Proposal. Protocols to prevent the introduction or spread of root rot would be developed prior to commencements of construction in consultation with DECCW.

4.9 Aquatic ecology

Sections 4.11 to 4.13 of the Working Paper describes the potential impacts on aquatic ecology associated with the Proposal along with mitigation measures (in Section 6.4) that have been incorporated into the Proposal design to reduce these impacts (for example, habitat disturbance of aquatic habitats and riparian corridors and potential impacts on aquatic fauna, fish passage, mangroves, seagrass and wetlands). Impacts and mitigation measures associated with riparian and aquatic habitat disturbance, maintenance of fish passage and water quality apply to the additional works proposed within Stumpy Creek and are discussed in the following sections. Mitigation measures specific to Stumpy Creek are provided in **Section 6.2** of this report.

4.9.1 Aquatic habitat disturbance

Riparian corridors and aquatic habitat

Potential impacts on the aquatic habitat and riparian corridor of Stumpy Creek would occur as a result of the construction and operation of the Proposal. A new service road crossing would be constructed for Stumpy Creek.

The creek crossing at Stumpy Creek would involve the construction of a new service road bridge that will cross the creek line to the east of the existing south bound bridge. The new bridge would be approximately 11.5 metres in width and have a deck length of 39.4 metres. The construction of the new service bridge crossing would involve vegetation removal, impacts on habitat within the riparian corridor of the creek and overshadowing of remaining vegetation.

At the proposed bridge crossing, construction would involve a disturbance area approximately 46 metres wide including the abutments and approach slab, which would be set back from the bank. Two piers would be located within this disturbance area outside the normal flow channel of Stumpy Creek. The bridge would be designed to assist in maintaining riparian connectivity and movement opportunities for native fauna along the banks of the watercourse. Mitigation measures for the

management of habitat values for the green-thighed frog, giant barred frog and bats within the riparian zone of Stumpy Creek are provided in **Section 6.1.1**.

Potential impacts on water quality could occur during the construction stage through vegetation clearance and disturbance to banks and during the operation of the Proposal as a result of sedimentation in runoff or from contaminants (for example, chemical and fuel spills). Measures to minimise impacts to riparian and aquatic habitat are contained within **Section 6.2**.

4.9.2 Aquatic fauna

The Proposal is unlikely to have an adverse impact on fish assemblages in Stumpy Creek given the implementation of specific design elements and mitigation measures to avoid impacts on water quality, riparian vegetation, aquatic habitats and fish passage (see **Section 6.2**).

No threatened fish species were recorded during the aquatic field survey. The Oxleyan pygmy perch and eastern freshwater cod are considered unlikely to occur given that the study area is located outside the known natural distribution and the absence of key habitat elements, it is considered highly unlikely that Stumpy Creek provides potential habitat for either of these species.

The Proposal has the potential to result in disturbance to the bed and bank of Stumpy Creek during construction, resulting in impacts to aquatic habitat. However, the mitigation measures described in **Section 6.2** would assist in avoiding or minimising such impacts.

4.9.3 Impacts on fish passage

One species identified during the aquatic survey, striped gudgeon (*Gobiomorphus australis*), requires unregulated longitudinal movement to facilitate and complete successful life cycles so that future generations could continue. The interruption of this could have a serious detrimental effect on the population dynamics of in-stream fauna.

The Proposal has the potential to result in disturbance to the bed and bank of the watercourse during construction, resulting in impacts to aquatic habitat. However, the mitigation measures described in **Section 6.2** would assist in avoiding or minimising such impacts.

The Proposal is highly unlikely to have any adverse impact on fish passage given that proposed bridge crossing would comply with the *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI 2003).

4.9.4 Managing changes to water quality in aquatic habitats

Measures that would be implemented to manage and mitigate the potential impacts on water quality are discussed in Chapter 13 of the *Oxley Highway to Kempsey Upgrading the Pacific Highway Environmental Assessment* (GHD 2010b), and include erosion and sedimentation control during construction and operation and progressive rehabilitation.

4.10 Changed hydrology

No significant alterations to the existing hydrology of the floodplain areas or associated impacts on watercourses or aquatic habitats are anticipated as a result of the Proposal. Measures to facilitate fish and amphibian crossings would be incorporated into the detailed design in accordance with the *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI 2003) to avoid modification of the natural hydrology of the creeklines and rivers within the study area.

4.11 Groundwater dependent ecological communities

The specific construction techniques would be determined at the detail design stage, and accordingly, the assessment of potential impacts on groundwater dependent ecological communities is necessarily general in nature. The likely impacts of construction on groundwater are discussed in Chapter 14 of the Environmental Assessment (GHD 2010b). These impacts are summarised and their relevance to potential groundwater dependent ecological communities addressed in Section 4.14 of the Working Paper (GHD 2010a). Much of the discussion of groundwater dependent ecological community impacts focuses on the vegetation, but there is an implied understating that the vegetation provides habitat for fauna species which may also be affected.

The vegetation communities identified within the study area are likely to be groundwater dependent to varying degrees, as discussed in the Flora and Fauna Working Paper (GHD 2010a) and Environmental Assessment (GHD 2010b). The Proposal is not likely to result in significant drawdown of groundwater, groundwater impedance or changes to the groundwater quality such that these ecosystems would be significantly detrimentally impacted.

4.12 Regional cumulative impacts

The cumulative impacts of the Proposal have been considered in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a) in terms of the additive impacts of multiple activities within the Mid-North Coast Region of NSW (as defined by NPWS 1999). These cumulative impacts are discussed in detail in Section 4.15 of the Working Paper (GHD 2010a).

The additional impacts of the Proposal that are attributed solely to the study area, which have not been previously estimated, would not result in any substantial cumulative impacts to those outlined in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a). An additional 0.4 hectares of native vegetation clearing will result from the study area, this being a small incremental increase that does not directly implicate any impacts on threatened species and EECs.

However an adjustment in the vegetation types being impacted was identified through the detailed investigations of previously inaccessible lands. The greatest adjustment is a net increased impact on Subtropical Coastal Floodplain Forest of 0.8 hectares, which is mirrored by reductions in Moist Slope Forest and Dry Ridgetop Forest vegetation types.

4.12.1 Endangered ecological communities

Four EECs likely to be impacted by the Proposal have been identified during previous surveys, these EECs and the extent of the proposed impact is discussed in Section 4.2 of the Working Paper.

Within the additional study areas the Proposal would impact three EECs, all of which have been identified during previous surveys.

The Comprehensive Regional Assessment of North Eastern NSW (NPWS 1999), undertaken as part of the regional forest agreement process, mapped broad floristic groups and forest structure to guide modelling of forest ecosystems, old growth forest, and flora and fauna communities in north-eastern NSW. This mapping provides a useful basis to assess the extent of impacts on EECs in a regional context.

Section 4.15.1 of the Flora and Fauna Working Paper discusses the extent in the Mid-North Coast Region of EECs impacted by the Proposal, as at 1999 when the National Parks and Wildlife Service assessment was carried out.

Table 4-4 shows the total areas of the EECs proposed to be cleared within the additional study areas. This figure is also expressed as a percentage of the total regional estimate of the extent of the endangered ecological community as existing in 1999.

Table 4-4 Proportion of the total area of endangered ecological communities in the Mid-North Coast Region of NSW likely to be impacted within the supplementary study area

Endangered ecological community impacted by the Proposal	Total estimated extent in the Region in 1999	Study area impact	Percentage of Regional extent impact
Swamp Sclerophyll Forest	29,155 ha	1.7 ha	0.0027 %
Swamp Oak Floodplain Forest	28,833 ha	0.8 ha	0.0028 %
Subtropical Coastal Floodplain Forest	60018 ha	1.2 ha	0.002 %
Freshwater Wetlands	24,118 ha	0.1 ha	0.00046 %

4.13 Key threatening processes

A 'key threatening process' is defined under the TSC Act as "*a threatening process specified in Schedule 3*" of the Act. A 'threatening process' is defined as"*a process that threatens, or may have the capability to threaten the survival or evolutionary development of species, populations or ecological communities*". A number of TSC Act listed key threatening processes are also listed as a key threatening process under the NSW FM Act and/or the Federal EPBC Act.

There are a diverse range of threats to biodiversity operating in the study area and wider region with many directly attributable to historic land uses or current human activities. The draft Northern Rivers Regional Biodiversity Management Plan, National Recovery Plan for the Northern Rivers Region (DECCW 2009) has identified and ranked priority threat categories and activities at a regional level and for four component landscape levels. The study area is contained within the Coastal Plains landscape of the Northern Rivers Region identified in the draft Management Plan.

An assessment of the contribution of the Proposal to key threatening processes identified in State and Federal legislation and corresponding priority threat activities identified for the coastal plains landscape of the Northern Rivers region that are of potential relevance to the Proposal is provided in Section 4.16 of the Working Paper (GHD 2010a).

In summary it is anticipated that the 'clearing of native vegetation' key threatening process would occur as a consequence of the Proposal within the study area. While the Proposal is expected to contribute to this key threatening process it is considered that the increased magnitude of 0.4 hectares is negligible in comparison to the total magnitude identified in the Environmental Assessment of 203.1 hectares.

5. Assessment of significance of impacts

5.1 Assessments of significance under Part 3A of the EP&A Act

The removal and/or disturbance of vegetation and habitats as a result of the Proposal has the potential to affect an array of threatened species that have been recorded or have the potential to occur in the study area. A number of endangered ecological communities would also be impacted. An assessment of the potential significance of impacts on these threatened species and ecological communities has been prepared in accordance with the assessment criteria identified in the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DECC and DPI 2005). The assessment is presented in **Appendix G** and summarised below.

5.1.1 Assessment of key thresholds

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

Specific impact mitigation and environmental management measures have been recommended for implementation to increase the certainty of the long term maintenance of the biodiversity values of the study area during construction and operation of the Proposal. This would substantially avert offsite impacts on surface waters, native vegetation and fauna habitats. The Proposal will not mitigate all impacts on native flora and fauna within the Proposal's footprint. There are residual impacts on native biota, including threatened species and EECs. These impacts will require commensurate biodiversity offsets to ensure the Proposal would "improve or maintain biodiversity values".

There is the potential for a number of direct and indirect impacts to occur on biodiversity values as a consequence of the Proposal. While most of these impacts have either been avoided, minimised through design decisions or can be adequately mitigated or managed, there are some impacts that cannot be adequately mitigated. To this end the Proposal has already been identified as affecting approximately 5.8 hectares of native vegetation of which approximately 3.8 hectares qualify as EECs (GHD, 2010a; GHD, 2010b).

Impacts identified within the study area add to these residual impacts as follows:

- Loss and degradation of native vegetation including communities that comprises EECs as listed under the TSC Act. The Proposal would affect approximately 5.8 hectares of native vegetation of which approximately 3.8 hectares qualify as EECs. A net increased impact on the subtropical floodplain eucalypt forest EEC is expected (0.8 hectares), which is a consequence of the revised vegetation mapping for previously unsurveyed areas.
- Loss of habitat for a variety of native species.

To address these residual impacts of the Proposal, the RTA would implement an offset strategy that would contribute to the long term conservation of biodiversity.

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

Assessments of significance have been performed for threatened biota known or likely to occur at the site and to be affected by the Proposal. The outcome of these assessments is that the Proposal is not likely to have a significant impact on any local populations of threatened biota.

The Proposal is unlikely to impose a significant adverse impact on any other threatened biota or their habitats based on the following considerations:

- There are no specific habitat features or resources at the site that suggest any permanent local populations of any other threatened biota are present.
- The Proposal will remove small areas of TSC Act listed EECs. The removal of these EECs would not compromise an ecologically significant proportion of the local occurrence of these communities.

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

As stated above, assessments of significance have been performed for threatened biota potentially affected by the Proposal and the outcome of these assessments is that the Proposal is not likely to have a significant impact on any local populations of threatened biota.

The Proposal is highly unlikely to accelerate the extinction of any other threatened biota, or place them at risk of extinction, based on the following considerations:

- There are no specific habitat features or resources in the study area that are likely to be important for maintaining local populations of any threatened biota. Areas of potential habitat of importance have been identified at Stumpy Creek with specific mitigation requirements recommended to minimise the impacts should the green-thighed frog or giant barred frog be identified at this location prior to construction.
- Considering the limited area of habitat within the Proposal footprint and the extent of alternative habitat in the locality, these areas are unlikely to contain an ecologically significant proportion of the local populations of any threatened biota.

Whether or not the proposal will adversely affect critical habitat.

No listed critical habitat will be removed or adversely affected as a result of the Proposal.

5.1.2 Conclusion

Based on the assessments undertaken, the Proposal is not considered likely to result in impacts of a magnitude that would cause a local population of threatened flora or fauna or a local occurrence of an endangered ecological community to become extinct. The significance assessments have concluded that there is unlikely to be a significant impact on threatened species or ecological communities provided that proposed mitigation and management measures are developed and implemented.

Habitats identified within the study area are known to support local populations of the large forest owls, microchiropteran bats, koala, spotted-tailed quoll, squirrel glider, brush-tailed phascogale, green-thighed frog and giant-barred frog. These species have been identified as particularly vulnerable to the impacts of the Proposal for the following reasons:

- Increased risk of mortality from collision with moving vehicles as a consequence of increased travel distance (eg koala, spotted-tailed quoll, squirrel glider and brush-tailed phascogale).
- Loss of habitat for sedentary species with specific habitat requirements (eg green-thighed frog and giant barred frog).
- Loss of habitat supporting breeding activity for species with large home ranges (eg large forest owls, microchiropteran bats, squirrel glider, brush-tailed phascogale).

The proposed mitigation. management and offset strategy would be designed to address these impact concerns.

5.2 Assessments of significance under the EPBC Act

The Proposal would not impact any world heritage places, national heritage places, Ramsar wetlands, commonwealth marine areas and would not involve any nuclear actions.

No threatened ecological communities listed under the EPBC Act were found to occur in the study area, and therefore none would be impacted by the Proposal.

An assessment of the potential significance of impacts of the Proposal on threatened and migratory species listed under the EPBC Act has been prepared in accordance with the significance criteria in the Administrative Guidelines for the Act (Department of Environment and Heritage 2006). The assessment is presented **Appendix H.**

The Proposal incorporates measures to minimise the clearing of vegetation, loss of habitat and drainage and sedimentation controls to manage runoff during both the construction and operation phases. On the basis of the assessments undertaken (**Appendix H)**, it is concluded that the Proposal is unlikely to result in a significant impact on any matter of national environmental significance under the EPBC Act, including threatened and migratory species. Accordingly, the Proposal has not been referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities.

6. Mitigation and management

The management of adverse impacts arising from the Proposal has been addressed in the Environmental Assessment (GHD 2010b) and the Working Paper (GHD 2010a). Management actions recommended in the Environmental Assessment and Working Paper were developed in accordance with the following hierarchy: avoidance; mitigation and offsetting of residual impacts. This is consistent with the approach outlined in the DEC/DPI (2005) guidelines.

The mitigation measures previously identified in the Environmental Assessment and Working Paper equally apply to the study area and have not been restated in this report unless amended to reflect specific mitigation issues. In this respect the following is a discussion of amended mitigation measure previously identified in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a) and any additional mitigation or management measures that are required as a result of the impacts identified in **Section 4**.

6.1 Terrestrial ecology

6.1.1 Minimising vegetation clearance and habitat loss

Disturbance and removal of areas of native vegetation and habitat would be unavoidable during the construction of the Proposal including additional areas identified within the study area. However, measures would be implemented to prevent further disturbance and minimise the impacts on the native vegetation and habitat. The following measures that would be implemented to minimise the loss of native vegetation and habitat for all the sites identified within the study area include:

- Avoidance of existing roadside native vegetation is preferable and should be considered in any detailed design for the service roads.
- Where possible clearing activities would not take place during the breeding period of most species (eg mid spring/early summer). Consideration would also be given to the avoidance of specific habitats such as tree hollows in the mid-autumn to mid-winter period (April to August), which is important for large forest owl breeding and microchiropteran bat torpor periods. Care would be required should clearing coincide with the koala breeding season (August to December).

Specific mitigation measures relevant to the green-thighed frog and giant barred frog at the Maria River crossing continue to apply to Stumpy Creek due to the presence of potential habitat for these species. These are detailed in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a).

6.1.2 Fragmentation, terrestrial barrier effects and road mortality

The types of fauna crossings identified in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a) that are specifically designed to mitigate the impacts of the Pacific Highway upgrade at locations that coincide with the study area are identified below. Descriptions for these are provided in the Environmental Assessment (GHD 2010b).

- One bridge underpass at Stumpy Creek (regional corridor).
- One combined crossing at Ravenswood Road (regional corridor).

- One combined crossing and two incidental crossings at Rodeo Drive.
- Two incidental crossings and one bridge crossing at Cooperabung Drive.

In addition to these prior recommended mitigation works it is considered that the widening of the trafficable width at Stumpy Creek, which coincides with a regional biodiversity corridor, warrants the integration of specific design features to aid all fauna crossing at this location. The underbridge crossing does not necessarily cater for the movement of glider species through this corridor and within this context it is recommended that an investigation into the installation of glider poles and / or above/below road rope crossing be undertaken for this location to reduce the potential risk of glider mortality.

The potential increase in traffic volume and vehicle speed at Ravenswood Road and Rodeo Drive raises the potential for fauna that successfully cross the Proposal at the designated crossing points to experience vehicle strike. In this respect it is recommended that the combined crossing located adjacent to the Ravenswood Road and Rodeo Drive service roads, as identified in the Environmental Assessment, be upgraded to a dedicated crossing to increase the likelihood of the koala and spotted-tailed quoll utilisation of this crossing. By increasing the certainty of fauna movement paths it is considered that additional complimentary targeted mitigation can be applied to the service roads. Targeted mitigation for the service roads include:

- Warning signs would be installed to alert road users as to the potential for encountering wildlife at locations where dedicated fauna crossings for the Proposal.
- The potential benefit of targeted advisory signs promoting reduced speed limits at locations that coincide with predicted fauna crossings would be investigated.

Further mitigation would consider the avoidance of roadside tree clearing during construction works to minimise gap widening. The use of additional tree plantings to address existing gaps or Proposal generated gaps, particularly at locations that have been identified in the Environmental Assessment (GHD 2010b) as fauna crossings, should also be considered.

No crossings have been planned for linking vegetation severed by the Proposal at Lot 1 DP 624721. It is recommended that an incidental crossing be installed to allow small ground fauna such as frog species to move freely through the floodplain at this location.

6.2 Aquatic ecology

6.2.1 Minimising Impacts on aquatic habitat

Minimal aquatic disturbance within Stumpy Creek is anticipated once construction of bridge crossing is completed. Damage to any aquatic habitat and riparian vegetation during construction would be minimised.

Care would be taken to minimise the potential impacts of construction to protect the hydrology and habitat values of the watercourse. Actions to achieve this include:

- The prevention of instream barriers that impede future flows or obstruct fish passage.
- Rehabilitation of riparian vegetation following completion of the works.
- Management of noxious and environmental weeds during and following construction.
- Installation of appropriate erosion and sediment control measures.
- The prevention of hazardous wastes from construction equipment entering the watercourse.

- The immediate notification of appropriate authorities should any pollution incident occur.

6.2.2 Aquatic fauna passage

The Working Paper (GHD 2010a) specifies measures to facilitate fish and amphibian crossings. These would be incorporated into the detailed design in accordance as per requirements contained in the DPI publications *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003) and *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI 2003).

6.2.3 Managing changes to water quality in aquatic habitats

Measures that would be implemented to manage and mitigate the potential impacts on water quality are discussed in the Environmental Assessment (GHD 2010b), and include erosion and sedimentation control during construction and operation and progressive rehabilitation.

6.2.4 Proposed management and mitigation measures for bridge construction

Disturbance and removal of riparian and aquatic habitat would be unavoidable during the construction of the service road bridge crossing at Stumpy Creek. However, measures would be implemented to minimise the impacts on the riparian vegetation and aquatic habitat. The following measures that would be implemented include:

- The bridge for the proposed creek crossing would be designed to minimise changes to the channel's natural flow, width, roughness and base-flow water depth to maintain fish passage.
- Vegetation clearing would be restricted to only those areas where it is necessary. Avoidance of existing riparian vegetation is preferable and should be considered in the detailed design stage for construction of the bridge.
- Areas of riparian vegetation to be cleared would be clearly marked on maps and delineated in the field to ensure that clearing does not occur beyond the area necessary for the Proposal.
- Woody snags would be treated in accordance with the requirements of DII, with removal of the snag being the last option. DII would be notified of any proposed works in relation to snags
- Prior to construction of the bridge structure, a work method statement would be prepared that identifies the site constraints and appropriate environmental management measures for the construction location at Stumpy Creek. The work method statement would include (but not limited to):
  - Vegetation clearance protocol which details approved areas of vegetation clearing and management of riparian corridor.
  - Weed management protocol which details management of noxious and environmental weeds during and post construction.
  - Rehabilitation Plan which details proposed creek rehabilitation works once construction is complete.
  - A progressive erosion and sediment control plan which details the appropriate erosion and sedimentation control measures that would be installed around the working site.

6.3 Offsetting

The Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a) outline the process involved in determining the extent of vegetation offsets required to mitigate the Proposal's impacts. These processes remain relevant to the offsetting of study area impacts.

The reclassification of mapped vegetation types resulted in the identification of an additional impact on Moist Floodplain Forest or Subtropical Coastal Floodplain Forest EEC (0.8 hectares) and Moist Gully Forest (1.6 hectares) at Stumpy Creek. Also at Stumpy Creek there is a reduction in the Proposals impacts on Dry Sclerophyll Forest by 2 hectares.

An offset strategy is to be prepared for the Proposal on the basis of the impacts presented in this report and the Working Paper (GHD 2010a) to address any residual impacts arising from the Proposal.

7. Conclusions

This ecological assessment identified within the study area a mix of ecological values that are predominantly consistent with the reported findings provided in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a). The extent, condition and conservation significance of native vegetation and habitats identified within the study area is broadly equivalent to that described in the GHD assessments for the Proposal (GHD 2010a, GHD 2010b).

However some additional impacts have been identified within the study area with the key differences between the study area and the remainder of the Proposal identified as follows:

- An increase of 0.4 hectares of native vegetation clearing.
- Net increased clearing of Subtropical Coastal Floodplain Forest of 0.8 hectares.
- Loss of foraging habitat for the hoary wattle bat at Stumpy Creek.

As already identified, this native vegetation is likely to contribute to the habitat extent for local populations of numerous threatened fauna species; a conclusion based on targeted surveys, habitat assessments and/or recent observations of the species in the locality. Some relatively intact habitats having high conservation significance including intact patches of the TSC Act listed EECs will be impacted, with some of these impacts additional to prior estimates (at Stumpy Creek).

The Proposal would result in impacts on native biota and their habitats through the clearing of 5.8 hectares of native vegetation. This vegetation also includes 3.8 hectares of vegetation consistent with the following TSC Act listed EECs:

- Swamp Sclerophyll Forest (1.7 hectares).
- Swamp Oak Floodplain Forest (0.8 hectares).
- Subtropical Coastal Floodplain Forest (1.2 hectares).
- Freshwater Wetlands (0.1 hectares).

The majority of these impacts have been previously identified in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a) and are predominantly consistent with the estimates provided in these assessments. However, additional impacts are expected including clearing of an additional 0.4 hectares of dry ridgetop forest at Stumpy Creek and 0.8 hectares of moist floodplain forest (as a result of reclassification of vegetation types after detailed study of previously inaccessible lands). The latter forms part of the subtropical coastal floodplain forest EEC.

The direct removal of this vegetation is not likely to comprise a significant reduction in the extent of these EECs and habitat for any local populations of native fauna. On this basis it is considered that the Proposal continues to meet the ‘maintain and improve test’ under Part 3A of the EP&A Act when considered within the context of the proposed mitigation measures identified in the Environmental Assessment (GHD 2010b) and Working Paper (GHD 2010a).

Furthermore, on the basis of the EPBC Act assessments of significance undertaken, it is concluded that the Proposal is unlikely to impose “a significant effect” on any Matters of National Environmental Significance.

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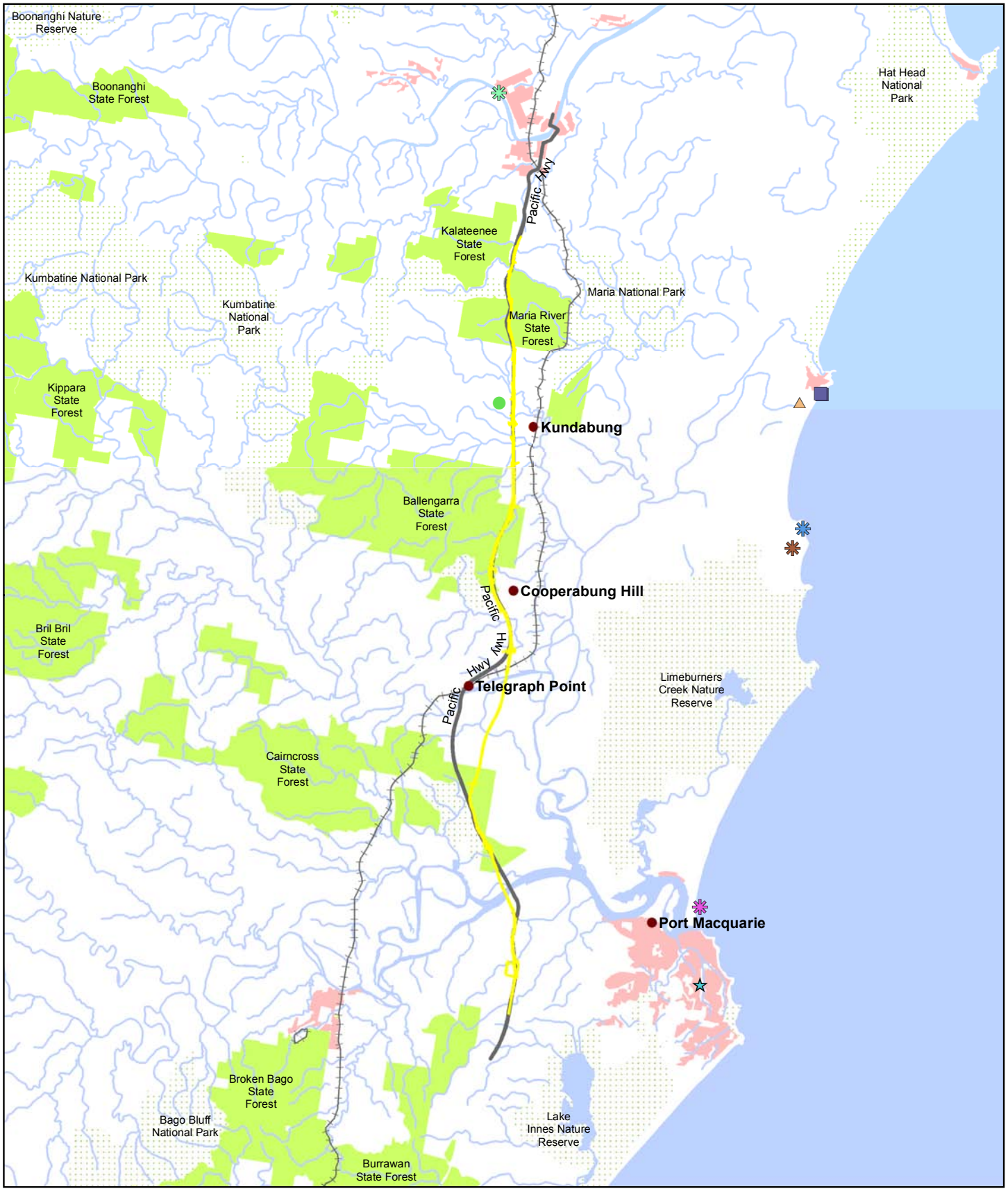
Appendix A

NSW DECCW Wildlife Atlas database search results



Legend

- Concept Design
- Railway
- Existing highway
- Watercourse
- Bulit-up urban areas
- National parks, Nature reserves
- State forests
- Austral Toad
- Hairy Jointg
- Sand Spurge
- Silverbush
- Willi Willi
- *Maundia triglochi*
- *Asperula asthenes*
- *Cynanchum elegans*
- *Thesium australe*

1:250,000(at A4)

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

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Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 05 NOV 2010

Threatened Flora Records

Figure 5

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com.au W www.ghd.com.au

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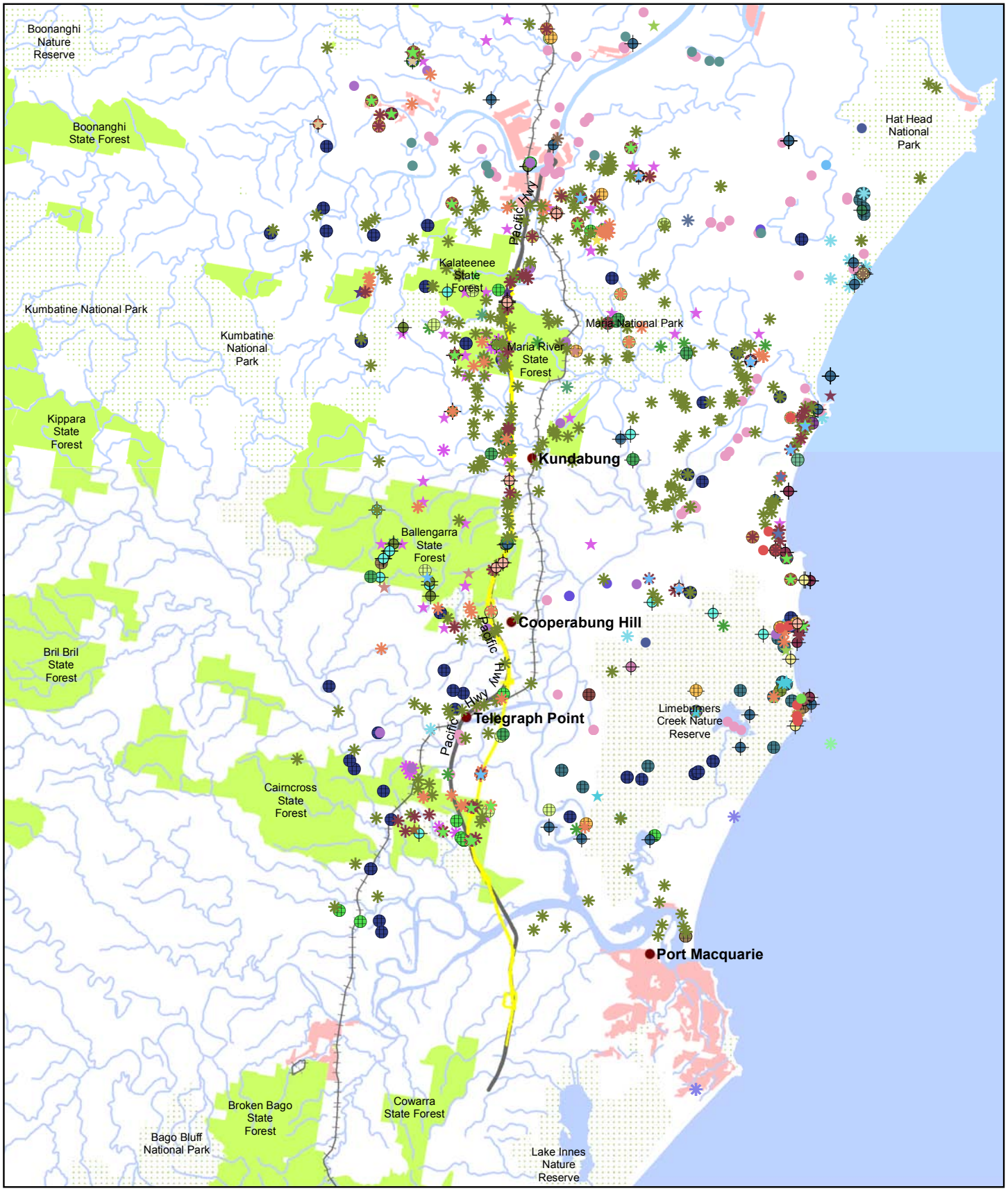
Data Source: Geosciences Australia: Topography - 2007; GHD: Concept Design - 2010; DECCW: Threatened Species Data - 2010. Created by: tmorton



Refer to Figure 6a for key to threatened fauna species.

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Metres
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 05 NOV 2010

Threatened Fauna Records

Figure 6

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com.au W www.ghd.com.au

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_006_Threatened_Fauna_20101104_A.mxd

Data Source: Geosciences Australia: Topography - 2007; GHD: Concept Design - 2010; DECCW: Threatened Species Data - 2010. Created by: tmorton

Threatened Fauna Records

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Barred Cuckoo-shrike
- Beach Stone-curlew
- Black Bittern
- Black Flying-fox
- Black-breasted Buzzard
- Black-necked Stork
- Blue-billed Duck
- Brolga
- Brown Treecreeper
- Brush-tailed Phascogale
- Bush Stone-curlew
- Comb-crested Jacana
- Common Blossom-bat
- Common Planigale
- Dugong
- Eastern Bentwing-bat
- Eastern Chestnut Mouse
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Long-eared Bat
- Eastern Pygmy-possum
- Flame Robin
- Flesh-footed Shearwat
- Flesh-footed Shearwater
- Freckled Duck
- Giant Barred Frog
- Giant Dragonfly
- Glossy Black-Cockatoo
- Golden-tipped Bat
- Grass Owl
- Greater Broad-nosed Bat
- Green Turtle
- Green and Golden Bell Frog
- Green-thighed Frog
- Grey-headed Flying-fox
- Hoary Wattled Bat
- Humpback Whale
- Koala
- Large-footed Myotis
- Lesser Sand-plover
- Little Bentwing-bat
- Little Eagle
- Little Lorikeet
- Little Tern
- Loggerhead Turtle
- Long-nosed Potoroo
- Marbled Frogmouth
- Masked Booby
- Masked Owl
- Olive Whistler
- Osprey
- Painted Honeyeater
- Painted Snipe
- Parma Wallaby
- Pied Oystercatcher
- Powerful Owl
- Regent Honeyeater
- Rose-crowned Fruit-Dove
- Rufous Bettong
- Rufous Scrub-bird
- Scarlet Robin
- Shy Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Myotis
- Southern Right Whale
- Sperm Whale
- Sphagnum Frog
- Spotted Harrier
- Spotted-tailed Quoll
- Square-tailed Kite
- Squirrel Glider
- Stephens' Banded Snake
- Stuttering Frog
- Swift Parrot
- Terek Sandpiper
- Turquoise Parrot
- Varied Sittella
- Wallum Froglet
- White-eared Monarch
- Wompoo Fruit-Dove
- Yellow-bellied Glider
- Yellow-bellied Sheathtail-bat

1:250,000 (at A4)

0 1,200 2,400 4,800 7,200 9,600

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Additional Field Survey

Threatened Fauna Records
Legend

Job Number 22-1374532
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Date 05 NOV 2010

Figure 6a

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Data Source: Geosciences Australia: Topography - 2007; GHD: Concept Design - 2010; DECCW: Threatened Species Data - 2010. Created by: tmorton

Appendix B

EPBC Act Protected Matters report

EPBC Act Protected Matters Report: Coordinates

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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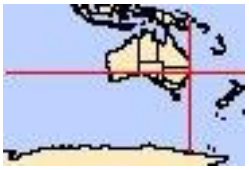

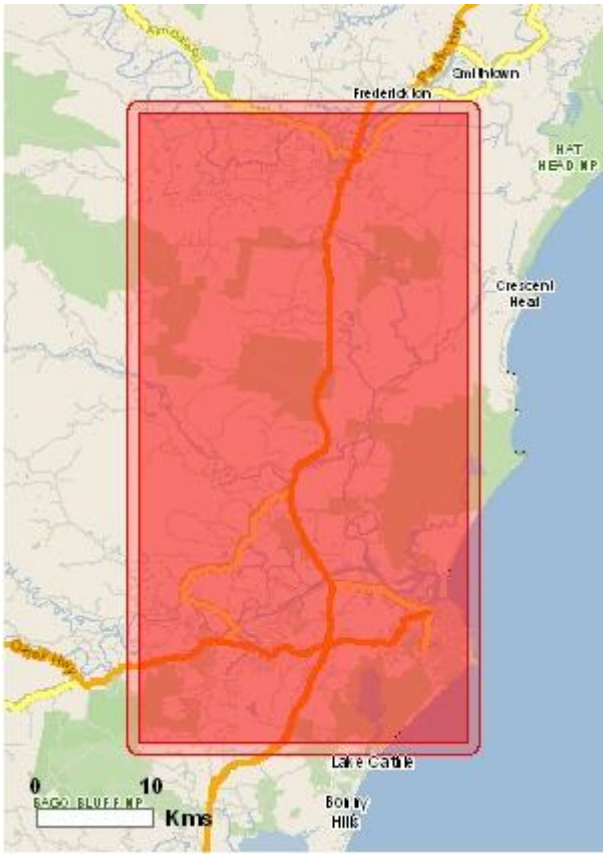

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 1Km

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance (Ramsar Wetlands):	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communitites:	1
Threatened Species:	50
Migratory Species:	59

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	8
Commonwealth Heritage Places:	1
Listed Marine Species:	74

Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves:	None

Report Summary for Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	23
State and Territory Reserves:	14
Regional Forest Agreements:	1
Invasive Species:	17
Nationally Important Wetlands:	2

Details

Matters of National Environmental Significance

Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area

Threatened Species [Resource Information]

Name	Status	Type of Presence
BIRDS		
Anthochaera phrygia		
Regent Honeyeater [82338]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans amsterdamensis		
Amsterdam Albatross [82330]	Endangered	Species or species habitat may occur within area
Diomedea exulans antipodensis		
Antipodean Albatross [82269]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans exulans		
Tristan Albatross [82337]	Endangered	Foraging, feeding or related behaviour may occur within area
Diomedea exulans gibsoni		
Gibson's Albatross [82271]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans (sensu lato)		
Wandering Albatross [1073]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor		
Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus		
Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area

Macronectes halli		
Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera		
Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta		
Kermadec Petrel (western) [64450]	Vulnerable	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri		
Buller's Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta cauta		
Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi		
White-capped Albatross [82344]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris impavida		
Campbell Albatross [82449]	Vulnerable	Species or species habitat may occur within area
FROGS		
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area
Litoria booroolongensis		
Booroolong Frog [1844]	Endangered	Species or species habitat may occur within area
Mixophyes balbus		
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
Mixophyes iteratus		
Giant Barred Frog, Southern Barred Frog [1944]	Endangered	Species or species habitat likely to occur within area
MAMMALS		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petrogale penicillata		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area

Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
PLANTS		
Allocasuarina defungens Dwarf Heath Casuarina [21924]	Endangered	Species or species habitat known to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Hakea archaeoides [66702]	Vulnerable	Species or species habitat likely to occur within area
Hydrocharis dubia Frogbit [3650]	Vulnerable	Species or species habitat likely to occur within area
Marsdenia longiloba Clear Milkvine [2794]	Vulnerable	Species or species habitat likely to occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat known to occur within area
Parsonsia dorrigoensis Milky Silkpod [64684]	Endangered	Species or species habitat likely to occur within area
Quassia sp. Moonee Creek (J.King s.n. 1949) NSW Herbarium [82054]	Endangered	Species or species habitat likely to occur within area
Taeniophyllum muelleri Minute Orchid, Ribbon-root Orchid [10771]	Vulnerable	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		

Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area

SHARKS

Carcharias taurus (east coast population)		
Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat may occur within area
Carcharodon carcharias		
Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Migratory Species [Resource Information]

Name	Status	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]		Species or species habitat may occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]		Species or species habitat may occur within area
Diomedea dabbenena		
Tristan Albatross [66471]		Foraging, feeding or related behaviour may occur within area
Diomedea exulans (sensu lato)		
Wandering Albatross [1073]	Vulnerable	Species or species habitat may occur within area
Diomedea gibsoni		
Gibson's Albatross [64466]		Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera		
Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Puffinus leucomelas		
Streaked Shearwater [66541]		Species or species habitat may occur within area
Sterna albifrons		
Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri		
Buller's Albatross [64460]	Vulnerable	Species or species habitat may occur within area

Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]		Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross [64459]		Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]		Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Merops ornatus		

Rainbow Bee-eater [670]	Species or species habitat may occur within area
Monarcha melanopsis	
Black-faced Monarch [609]	Breeding may occur within area
Monarcha trivirgatus	
Spectacled Monarch [610]	Breeding likely to occur within area
Myiagra cyanoleuca	
Satin Flycatcher [612]	Breeding likely to occur within area
Rhipidura rufifrons	
Rufous Fantail [592]	Breeding may occur within area
Xanthomyza phrygia	
Regent Honeyeater [430]	Species or species habitat likely to occur within area

Migratory Wetlands Species

Actitis hypoleucos	
Common Sandpiper [59309]	Roosting known to occur within area
Ardea alba	
Great Egret, White Egret [59541]	Species or species habitat may occur within area
Ardea ibis	
Cattle Egret [59542]	Species or species habitat may occur within area
Arenaria interpres	
Ruddy Turnstone [872]	Roosting known to occur within area
Calidris canutus	
Red Knot, Knot [855]	Roosting known to occur within area
Calidris ruficollis	
Red-necked Stint [860]	Roosting known to occur within area
Charadrius bicinctus	
Double-banded Plover [895]	Roosting known to occur within area
Charadrius mongolus	
Lesser Sand Plover, Mongolian Plover [879]	Roosting known to occur within area
Gallinago hardwickii	
Latham's Snipe, Japanese Snipe [863]	Roosting may occur within area
Heteroscelus brevipes	
Grey-tailed Tattler [59311]	Roosting known to occur within area
Limosa lapponica	
Bar-tailed Godwit [844]	Roosting known to occur within area
Numenius madagascariensis	
Eastern Curlew [847]	Roosting known to occur within area
Numenius minutus	
Little Curlew, Little Whimbrel [848]	Roosting likely to occur within area
Numenius phaeopus	
Whimbrel [849]	Roosting known to occur within area
Pluvialis fulva	
Pacific Golden Plover [25545]	Roosting known to occur within area
Pluvialis squatarola	
Grey Plover [865]	Roosting known to occur within area
Rostratula benghalensis s. lat.	
Painted Snipe [889]	Species or species habitat may occur within area
Xenus cinereus	

Terek Sandpiper [59300] Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Broadcasting Commission
Defence - 41 RNSWR KEMPSEY ; KEMPSEY GRES DEPOT
Commonwealth Land - Telstra Corporation Limited
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Commonwealth Bank of Australia

Commonwealth Heritage Places [Resource Information]

Name	Status
Historic	
Kempsey Post Office NSW	Nominated place

Listed Marine Species [Resource Information]

Name	Status	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Roosting known to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres		
Ruddy Turnstone [872]		Roosting known to occur within area
Calidris canutus		
Red Knot, Knot [855]		Roosting known to occur within area
Calidris ruficollis		
Red-necked Stint [860]		Roosting known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat may occur within area
Catharacta skua		
Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus		
Double-banded Plover [895]		Roosting known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]		Roosting known to occur within area
Charadrius ruficapillus		
Red-capped Plover [881]		Roosting known to occur within area
Diomedea amsterdamensis		

Amsterdam Albatross [64405] Diomedea antipodensis		Species or species habitat may occur within area
Antipodean Albatross [64458] Diomedea dabbenena		Species or species habitat may occur within area
Tristan Albatross [66471] Diomedea exulans (sensu lato)		Foraging, feeding or related behaviour may occur within area
Wandering Albatross [1073] Diomedea gibsoni	Vulnerable	Species or species habitat may occur within area
Gibson's Albatross [64466] Gallinago hardwickii		Species or species habitat may occur within area
Latham's Snipe, Japanese Snipe [863] Gallinago megala		Roosting may occur within area
Swinhoe's Snipe [864] Gallinago stenura		Roosting likely to occur within area
Pin-tailed Snipe [841] Haliaeetus leucogaster		Roosting likely to occur within area
White-bellied Sea-Eagle [943] Heteroscelus brevipes		Species or species habitat likely to occur within area
Grey-tailed Tattler [59311] Hirundapus caudacutus		Roosting known to occur within area
White-throated Needletail [682] Lathamus discolor		Species or species habitat may occur within area
Swift Parrot [744] Limosa lapponica	Endangered	Species or species habitat likely to occur within area
Bar-tailed Godwit [844] Macronectes giganteus		Roosting known to occur within area
Southern Giant-Petrel [1060] Macronectes halli	Endangered	Species or species habitat may occur within area
Northern Giant-Petrel [1061] Merops ornatus	Vulnerable	Species or species habitat may occur within area
Rainbow Bee-eater [670] Monarcha melanopsis		Species or species habitat may occur within area
Black-faced Monarch [609] Monarcha trivirgatus		Breeding may occur within area
Spectacled Monarch [610] Myiagra cyanoleuca		Breeding likely to occur within area
Satin Flycatcher [612] Numenius madagascariensis		Breeding likely to occur within area
Eastern Curlew [847] Numenius minutus		Roosting known to occur within area
Little Curlew, Little Whimbrel [848] Numenius phaeopus		Roosting likely to occur within area
Whimbrel [849] Pluvialis fulva		Roosting known to occur within area
Pacific Golden Plover [25545] Pluvialis squatarola		Roosting known to occur within area
Grey Plover [865]		Roosting known to occur within area

Rhipidura rufifrons		
Rufous Fantail [592]		Breeding may occur within area
Rostratula benghalensis s. lat.		
Painted Snipe [889]		Species or species habitat may occur within area
Sterna albifrons		
Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri		
Buller's Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto)		
Shy Albatross, Tasmanian Shy Albatross [64697]		Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross [64459]		Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi		
White-capped Albatross [64462]		Species or species habitat may occur within area
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura tentaculata		
Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Festucalex cinctus		
Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris		
Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys heptagonus		
Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus		
Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus whitei		
White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat may occur within area
Histiogamphelus briggsii		
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Lissocampus runa		
Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata		
Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Solegnathus dunckeri		
Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Solegnathus spinosissimus		
Spiny Pipehorse, Australian		Species or species habitat may occur within area

Spiny Pipehorse [66275]		
Solenostomus cyanopterus		
Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paegnius		
Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
Solenostomus paradoxus		
Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Stigmatopora nigra		
Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus		
Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus		
Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris		
Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri		
New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus		
Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Hydrophis elegans		
Elegant Seasnake [1104]		Species or species habitat may occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Pelamis platurus		

Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and Other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata		
Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata		
Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis		
Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus		
Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata		
Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus		
Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	Status
Natural	
Kendall Forestry Management Area State Forests NSW	Indicative Place
Lake Innes Nature Reserve and Adjacent Areas NSW	Indicative Place
Limeburners Creek Nature Reserve NSW	Registered
Macquarie Nature Reserve NSW	Registered
Port Macquarie Coastal Rocks NSW	Registered
Sea Acres Area NSW	Registered
Yessabah Caves Area NSW	Registered

Indigenous	
Connection Creek Shell Middens NSW	Indicative Place
Rollands Plains Stone Arrangement NSW	Indicative Place
Sherwood Canoe Tree NSW	Indicative Place
Historic	
Douglas Vale NSW	Indicative Place
Kundabung Lime Kiln Ruins NSW	Indicative Place
Lady Nelson Wharf NSW	Indicative Place
PS Ballina NSW	Indicative Place
Port Macquarie Historic Settlement Area NSW	Indicative Place
Port Macquarie Rifle Range NSW	Indicative Place
Wesleyan Methodist Church NSW	Indicative Place
Kempsey Courthouse NSW	Registered
Kempsey Post Office NSW	Registered
Pipers Creek Lime Kilns NSW	Registered
Port Macquarie Courthouse NSW	Registered
Port Macquarie Government House Site NSW	Registered
St Thomas the Apostle Anglican Church NSW	Registered

State and Territory Reserves [Resource Information]

Sea Acres, NSW
Kumbatine, NSW
Cooperabung Creek, NSW
Boonanghi, NSW
Bago Bluff, NSW
Lake Innes, NSW
Yessabah, NSW
Rawdon Creek, NSW
Maria, NSW
Queens Lake, NSW
Woregore, NSW
Macquarie, NSW
Lake Innes, NSW
Limeburners Creek, NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.
North East NSW RFA, New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Frogs		
Bufo marinus		
Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
Bubalus bubalis		
Water Buffalo, Swamp Buffalo [1]		Species or species habitat may occur within area

Capra hircus Goat [2]	Species or species habitat may occur within area
Felis catus Cat, House Cat, Domestic Cat [19]	Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]	Species or species habitat may occur within area
Sus scrofa Pig [6]	Species or species habitat may occur within area
Vulpes vulpes Red Fox, Fox [18]	Species or species habitat likely to occur within area

Plants

Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]	Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]	Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]	Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]	Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]	Species or species habitat may occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]	Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]	Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]	Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]	Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]	Species or species habitat may occur within area

Nationally Important Wetlands **[Resource Information]**

Clybucca Creek Estuary, NSW
Limeburners Creek Nature Reserve, NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:
- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:
- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly 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.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

152.6757
-31.04887,152.92981
-31.04887,152.92981
-31.53657,152.6757
-31.53657,152.6757
-31.04887

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix C

Methodology

SURVEY METHODOLOGY

Literature review

A literature review was undertaken as part of the desktop assessment process and included the following:

- The Commonwealth Department of the Environment, Sustainability, Environment, Water, Population and Communities (DSEWPC) website-based EPBC Act Protected Matters Search Tool.
- The NSW Department of Environment and Climate Change (National Parks and Wildlife Service) *Wildlife Atlas* database for threatened species and ecological communities.
- Department of Environment and Climate Change (DECC) Atlas of NSW Wildlife database (as at May 2007) for the Kempsey (9435) and Camden Haven (9434) 1:100,000 map sheets.
- The National Herbarium of NSW *PlantNet* database for threatened and other significant species.
- The Commonwealth Department of Environment and Heritage database for nationally listed threatened species and 'Important Wetlands'.
- Listings of rare or threatened species in Briggs and Leigh (1996) Rare or Threatened Australian Plants (ROTAP).
- The NSW Fisheries database for threatened and protected aquatic species and ecological communities.
- NSW Department of Primary Industries (DPI) Threatened Species Records View for threatened aquatic fauna species
- The Australian Museum *FaunaNet* database for threatened and protected aquatic species.
- Dr. Vanessa Standing's report on koala sightings recorded in the Advanced Ecological Assessment of the Concept Design: Pacific Highway upgrade–Oxley Hwy to Kempsey Terrestrial Flora and Fauna Final Draft Report March 2008 Ecotone Ecological Consultants Pty Ltd on the Pacific Highway between Port Macquarie and Kempsey.

Terrestrial flora

A combination of quadrats, transects and targeted searches for threatened species were used to survey the study area. Vegetation mapping was undertaken using a combination of sampling quadrats and walking transects. Within the private properties assessed sampling quadrats (400 square metres in size) were placed randomly within each vegetation community and used to collect structural and floristic data. All species present within each quadrat were recorded and a cover abundance ranking assigned to each species. Notes were also taken on the dominant species, soil type and condition, the level of weed invasion and any other signs of disturbance.

Transects

Walking transects were employed to ascertain vegetation community boundaries, record species not observed within sampling quadrats and to search for threatened species within areas of suitable habitat. GPS points were recorded where vegetation boundaries along walking transects where detected, as well as locations of significance for flora including threatened species. Transect surveys were undertaken along all three of the service road reserves.

The linear nature of the study area dictated a more continuous traverse along, and to either side of, the proposed alignment centreline, rather than a series of separate and disconnected traverses. Accordingly, a traverse on foot by two observers was conducted involving transects in sections that collectively covered the entire length of the study area. Within each transect the range of floristic variation, vegetation structure, extent of modification, disturbance, weed invasion and condition of the vegetation generally was assessed and recorded. All vascular flora species encountered were recorded in all areas.

Quadrats

The draft flora and fauna survey guidelines (DEC 2004) suggest the following numbers of sample plots (400 square metre quadrats) to be examined per stratification unit (vegetation community):

- One quadrat per stratification unit < 2 hectares.
- Two quadrats per stratification unit of 2 to 50 hectares.
- Three quadrats per stratification unit of 51-250 hectares.

Broad stratification units were determined prior to the survey based on prior habitat assessment within the study area in combination with a review of information from previous vegetation mapping within the area, aerial photography and topographic maps. No individual stratification unit was found to exceed 250 hectares in total, therefore one, two or three 400 square metre quadrats were examined per vegetation community, depending on the total area each community covered. Quadrat locations were chosen subjectively within each community to include a representative sample of the vegetation of that community. Quadrat configuration for all quadrats was 20 x 20 metres. All vascular flora species, habitat and structural vegetation characteristics were recorded from the quadrats.

EEC mapping and verification

Mapping of Endangered Ecological Communities (EEC), was verified based on the community description and characteristic species listed in the NSW Scientific Committee (NSW SC) Final Determinations (2004a, 2004b, 2004c), and the results of the vegetation quadrat data.

Targeted rare or threatened flora species surveys

Targeted flora surveys were undertaken throughout the study area in areas for which threatened flora have the potential to occur. The targeted flora surveys included random meander transects within areas for which threatened flora have the potential to occur, and mapping of potential habitat for threatened species.

Although few rare or threatened flora species have, to date, been recorded in or near the study area, more intense targeted random meander surveys were undertaken in areas considered to contain suitable habitat for the threatened flora species determined to be most likely to occur (rated as high or moderate likelihood). In all areas surveyed, the possible presence of any unexpected rare or threatened species in a typical habitat was considered during examination of the transects and quadrats. Although DECCW advised that the species was of no concern, targeted threatened flora surveys included consideration of the possible presence of *Adenostemma lavenia*, since it was one of the Director - General's requirements for the Part 3A assessment.

Photographs

At least one colour photograph was taken of a representative view of each vegetation community. Small samples of any plant species that could not be identified in the field were obtained for further examination and identification.

Terrestrial fauna

The broad stratification units determined for flora survey work were refined as a basis for determining fauna survey sites within the study area. Survey sites were chosen so as to provide the best possible sampling of each fauna habitat type within the study area. This included situating traplines within each native vegetation community, ensuring that specific fauna habitat features (for example, water bodies) were adequately surveyed and identifying areas for targeted surveys for specific threatened fauna species. The following field survey methodologies were used:

Habitat assessment

Habitat assessments were carried out using walked traverses of all habitat types throughout the study area to identify potential habitats for fauna, particularly threatened species. Attention was paid to detecting relevant features or resources for native fauna (in particular threatened species) known from the locality (such as hollow-bearing trees, rock outcrops, hollow logs, specific food trees and water features). Scats were collected and identified. Tree hollows were inspected (where possible) for evidence of use by fauna (for example, worn entrances, whitewash).

Traverses included searching for:

- Evidence of native fauna (for example, nesting material, owl white-wash, dreys, evidence of foraging) below mature trees.
- Birds and other diurnally active fauna.
- Trees with bird nests or other potential fauna roosts.
- Burrows, dens and warrens.
- Distinctive scats, tracks, animal remains, feathers, bones, fur, nests, burrows and diggings.
- Evidence of activity such as scratches and diggings.
- Stags and tree-hollows that provide potential roost sites for bats, owls, and other hollow-dependant species.

Experienced field staff identified all scats and bone remains on-site. Potential feed trees for species such as the Swift Parrot (*Lathamus discolor)*, Regent Honeyeater (*Xanthomyza phrygia)* and Koala were also sought and noted during the field surveys.

Live trapping transects

In order to target arboreal mammals, ten 'B' Elliott traps (measuring 46 centimetres x 15 centimetres x 15 centimetres) were positioned in trees along a transect. Each trap was mounted on a platform attached to a selected tree at a height of approximately 2 metres. All traps were positioned so as to avoid the morning sun. Traps were baited with standard peanut butter and rolled oat mixture and candied honey.

In order to target terrestrial mammals, 25 'A' Elliott traps (measuring 33 centimetres x 10 centimetres x 9 centimetres), were set out on the ground along a transect. 'A' Elliott traps were baited with peanut butter, honey and rolled oat balls, In order to provide shade and shelter, all traps were covered with plant material and placed in a shady position.

All traps were checked early each morning for captures, with any captured animals identified and immediately released.

Diurnal bird census

Diurnal bird surveys were undertaken in the early morning and at dusk by one observer for a period of at least 20 minutes. All birds positively identified either by direct visual observation or by their characteristic call during this period were recorded.

Koala scat and activity search

Each koala scat survey involved a search for koala scat and other evidence of koala activity at the base of twenty potential koala food trees (as listed in SEPP 44). During all searches, only trees over 10 centimetres diameter were targeted.

Nocturnal call playback

The playback of pre-recorded calls of threatened nocturnal fauna species (squirrel glider, koala, yellow-bellied glider, powerful owl, masked owl and barking owl) within appropriate habitat throughout the survey area and in various areas outside of the study area to determine local occurrence and distribution. Surveys involved an initial listening period of approximately 10 minutes, call playing for five minutes followed by a listening period of two minutes (undertaken separately for each species), and a final listening period of approximately 10 minutes. A general spotlight of the area followed the final listening period. Calls were played through a MP3 player connected to a 15 watt megaphone. During all spotlighting surveys nocturnal bird species were also targeted.

Spotlighting

Spotlight searches for nocturnally active mammals and birds were carried out at all designated survey sites as well as opportunistically across the entire study area. Surveys were undertaken throughout the study area in all habitat types present. Surveys targeted all nocturnal arboreal mammal species (for example, koala), nocturnal bird species (e.g. powerful owl) and the larger ground-dwelling mammals potentially occurring within the study area. Targeted surveys for arboreal mammals were undertaken to specifically target the threatened yellow-bellied glider (*Petaurus australis),* squirrel glider (*Petaurus norfolcensis)* and koala.

Mammals and nocturnal birds were identified by observation under spotlight or by vocalisations heard whilst spotlighting. Each survey period involved a series of transects conducted on foot at approximately 1 kilometre per hour or from a vehicle travelling at approximately 5 kilometres per hour. Vehicle transects were undertaken in several locations where access was possible since these surveys are able to target a larger area per unit of survey time. Foot transects were undertaken where vehicles were not appropriate, either due to access or density of vegetation.

Herpetofauna

Surveys for frogs and reptiles were carried out at all designated sampling sites as well as opportunistically across the study area. The survey techniques employed targeted all frog and reptile species potentially occurring within the study area, and included:

- Diurnal searches for sheltering or basking frogs and reptiles.
- Listening for frog calls during diurnal and nocturnal census periods.
- Active shelter searches.
- Nocturnal spotlighting.
- Driving transects during wet weather (spotlighting and auditory surveys).

Targeted searches for frogs around dams, streams and other wet areas within the study area were undertaken. Each survey involved identifying any vocal frog species by their unique call as well as a search for frogs under rocks, by the edge of the water, on floating vegetation, in fringing grass or other vegetation, under logs and other debris. Each search was undertaken during the evening, with some searches commencing just before dusk. The length of time spent searching at each site varied between approximately 30 minutes.

Reptile surveys were undertaken during mid-morning or mid-afternoon when temperatures were suitable for reptile activity. All reptiles positively identified during this period were recorded.

Microchiropteran bat surveys

Anabat surveys

Insectivorous bats were surveyed using ultrasonic call detection. Anabat CFZCAIM detectors were left out overnight to collect ultrasonic calls of the bat species within the study area. Bats emit ultrasonic calls as a method of navigating and searching for food. These calls are often at a higher frequency than calls audible to the human ear. In order to make the calls audible, bat detectors convert the call to a lower frequency.

Calls collected during the field survey were identified using zero-crossing analysis and AnalookW software (version 3.6g, Chris Corben 2009) by visually comparing call traits. The analysis of all bat calls was undertaken by GHD ecologist Mark Aitkens. The *Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay *et al*. 2004) was used as a guide to call analysis. Due to the high level of variability and overlap in call characteristics, a conservative approach was taken when analysing calls.

Anabats have proved useful for recording species that are difficult to capture. However, owing to variations in call strength and frequency within and between species and the difficulty in identifying short or poor quality calls, the identity of species recorded by a bat detector cannot always be guaranteed. Some bats are difficult to detect due to their quiet calls (for example, *Nyctophilus* sp., *Kerivoula papuensis*) and bats with extremely similar calls are sometimes difficult to differentiate (for example, *Miniopterus schreibersii oceanensis* and *Vespadelus darlingtoni*). Therefore, bat detectors cannot always provide positive species identification.

Targeted bat searches

Active bat searches at potential roosting sites under bridges and within culverts at relevant points along the highway were conducted.

Harp traps

A harp trap was set up along a suitable flight path along Stumpy creek. The trap was left in place for three nights and checked once during the night and early each morning for captures.

Opportunistic observations

All fauna observed or heard during the field surveys was recorded. Characteristic signs, tracks, trails and other indirect evidence of fauna species from all fauna groups were also recorded.

Aquatic Ecology

Electrofishing

Electrofishing was not able to be conducted due to low electrical conductivity levels, which hinders the electrical charge emitted by the electrofishing unit.

Fyke Netting

Fyke nets were employed in more open areas of Stumpy Creek (sites 3 and 4) with the aim of collecting a range of larger, migratory and more mobile species. Two small mesh single-wing fykes were deployed, left set overnight for a 12 hour period. All nets were set to ensure that a diversity of available structural habitat was sampled (open water, amongst or against vegetation and woody material). On site, habitat information was used to inform the appropriate sampling approaches to achieve the required outcomes of characterising the aquatic faunal assemblages of the study area. Single wing fyke nets (small mesh) were used. Nets have a central wing (8 metres x 1.2 metres) attached to the first supporting hoop (diameter = 0.65 metres) with a stretched mesh size of 5 millimetres.

Bait Trapping

Bait traps were employed at each of the survey sites at Stumpy Creek. They are an efficient method of sampling small fish amongst woody debris, dense vegetation, steep banks and deep water; habitat variables that featured at the study sites. Bait traps have a funnelled opening at each end (0.22 metres x 0.22 metres x 0.4 metres, with 2 millimetres stretched mesh) and were set in the littoral zone close to emergent vegetation, submerged macrophytes and woody debris.

All traps were baited with glow sticks and set in the afternoon and retrieved in the morning for specimen removal and processing.

Specimen Processing

All specimens collected were identified, weighed, measured then recorded prior to being returned to the watercourse at point of capture. All specimens were identified to species level in the field using *Field Guide to the Freshwater Fishes of Australia* (Allen *et al*. 2002). GHD currently holds a Scientific Research Permit (P07/0142-3.0, NSW, Expiry date: 31/08/2013) for the collection of aquatic biota, which also complies with Animal Ethics Legislation.

Aquatic Habitat Assessments

Detailed documentation of aquatic habitats and features were conducted at each site in order to determine the condition of aquatic habitats and the suitability of the watercourse for threatened aquatic fauna and flora, including threatened species, population and communities listed under the FM Act and / or EPBC Act such as the Oxleyan pygmy perch (*Nannopeca oxleyana*) and eastern freshwater cod (*Maccullochella ikei*).

Assessments were undertaken following the Australian River Assessment Systems: AUSRIVAS Physical Assessment Protocol (AUSRIVAS, 2009) and included descriptions of a number of characteristics at each site e.g. water quality, local impacts, landuse, floodplain features, riparian zone composition and condition, in-stream physical characteristics, bank form and stability, sediment composition and condition and macrophyte species presence.

Macrophyte species were identified in the field using *Waterplants in Australia, 4th Edition* (Sainty & Jacobs, 2003). Incidental sightings of other aquatic species were also recorded.

Water Quality Assessment

Basic physico-chemical water quality parameters were measured using a TPS 900 portable water quality meter. The variables measured were as follows:

- Temperature (^{o}C).
- pH.
- Turbidity (NTU).
- Dissolved oxygen (DO) (mg/L and per cent saturation).
- Electrical conductivity (EC) (μS/cm^{2}).

All water quality results were compared to the Australian and New Zealand Environment Conservation Council (ANZECC) 2000 water quality guidelines for lowland rivers / streams.

Appendix D

Flora species recorded in the study area

Table D1 Recorded flora

Family	Scientific Name	Common Name	Exotic	Q1	Q2	Q3	Q4	Q5	Q6	Incidentals Lot 1 DP 624217	Cooperbung Drive	Rodeo Drive	Ravenswood Road	Ravenswood Road lower slopes
ACANTHACEAE	*Brunoniella australis*	Blue Trumpet/ Native Yam		2				2						
ACANTHACEAE	*Brunoniella sp*	Blue Trumpet			1									
APIACEAE	*Hydrocotyle peduncularis*	Hairy Pennywort				2	2	2	2				X	
APIACEAE	*Hydrocotyle tripartita*	Pennywort				2	2		2					
APOCYNACEAE	*Parsonsia straminea*	Common Silkpod					1		2	X				
APOCYNACEAE	*Tabernaemontana pandacaqui*	Banana Bush / Windmill Bush					4							
ARALIACEAE	*Polyscias sambucifolia*	Ornamental Ash	Yes									X		
ASPARAGACEAE	*Asparagus aethiopicus*	Asparagus Fern	Yes									X		
ASTERACEAE	*Ageratina adenophora*	Crofton Weed	Yes							X				
ASTERACEAE	*Ageratum houstonianum*	-				2								
ASTERACEAE	*Ambrosia artemisiifolia*	Annual Ragweed	Yes									X		
ASTERACEAE	*Bidens pilosa*	Cobblers Pegs	Yes					1						
ASTERACEAE	*Cirsium vulgaris*	Spear Thistle / Black Thistle	Yes		1									
ASTERACEAE	*Conyza sp.*	Fleabane	Yes								X			
ASTERACEAE	*Hypochoeris radicata*	Flatweed	Yes								X			
ASTERACEAE	*Ozothamnus diosmifolius*	Ball Everlasting		1									X	
ASTERACEAE	*Taraxacum officinal*	Dandelion	Yes		1		1	2					X	
BLECHNACEAE	*Blechnum sp*	Fishbone Fern								X				
BRASSICACEAE	*Capsella bursa-pastoris*	Shepherd's Purse	Yes										X	
CASUARINACEAE	*Allocasuarina littoral*	Black She-oak		4			1	2					X	
CASUARINACEAE	*Allocasuarina torulosa*	Forest Oak												X
CASUARINACEAE	*Casuarina glauca*	Swamp She-oak						4			X			
COMMELINACEAE	*Commelina cyanea*	Scurvy Weed								X				
CONVOLVULACEAE	*Convolvulus erubescence*	Blushing Bindweed			2	2		2	2					
CYPERACEAE	*Carex breviculmis?*	-				2	2	2						
CYPERACEAE	*Carex longebrachiata*	Drooping Sedge							2					
CYPERACEAE	*Cyperus eragrostis*	Umbrella Sedge	Yes				2							
CYPERACEAE	*Eleocharis sphacelata*	Tall Spike-rush								X				

Family	Scientific Name	Common Name	Exotic	Q1	Q2	Q3	Q4	Q5	Q6	Incidentals Lot 1 DP 624217	Cooperbung Drive	Rodeo Drive	Ravenswood Road	Ravenswood Road lower slopes
CYPERACEAE	*Gahnia aspera*	Rough Saw-sedge												X
CYPERACEAE	*Gahnia sieberiana*	Red-fruited Saw-sedge					2	2	1					
CYPERACEAE	*Lepidosperma lateral*	Flat Sword-sedge		2	2									
DENNSTAEDTIACEAE	*Pteridium esculentum*	Bracken Fern			3		2	2					X	
DICKSONIACEAE	*Calochlaena dubia*	False Bracken Fern				3	2		2					
DILLENIACEAE	*Hibbertia aspera*	Rough Guinea-flower					1							
DILLENIACEAE	*Hibbertia empetrifolia subsp. empetrifolia*	Trailing Guinea-flower				2								
DILLENIACEAE	*Hibbertia scandens*	Golden Guinea Flower				2								
DILLENIACEAE	*Hibbertia sp*	Guinea Flower			2									
DIOSCOREACEAE	*Dioscorea transversa*	Native Yam				2								
ERICACEAE	*Leucopogon sp*	Beard-heath		1										X
EUPHORBIACEAE	*Breynia oblongifolia*	Coffee Bush			2				1					X
EUPHORBIACEAE	*Glochidion ferdinandi var. ferdinandi*	Cheese Tree						2						
FABACEAE	*Acacia falcata*	-											X	
FABACEAE	*Acacia floribunda*	White Sallow Wattle/Sally							1					
FABACEAE	*Acacia irrorata subsp irrorata*	Green Wattle				1		1					X	
FABACEAE	*Acacia linifolia*	Narrow-leaf Wattle		1	2	1	2					X	X	
FABACEAE	*Acacia longifolia*	-											X	
FABACEAE	*Acacia maidenii*	Maiden's Wattle		2	2									
FABACEAE	*Acacia melanoxylon*	Blackwood									X			
FABACEAE	*Acacia venulosa*	Wattle			2									
FABACEAE	*Daviesia ulicifolia*	A Bitter Pea			1									
FABACEAE	*Desmodium varians*	Slender Tick-trefoil			2	2							X	
FABACEAE	*Glycine clandestina*	A Love Creeper / Twining Glycine		2										
FABACEAE	*Glycine microphylla*	Small-leafed Glycine					2							
FABACEAE	*Glycine tabacina*	A Love Creeper				2								
FABACEAE	*Hardenbergia violaceae*	False Sarsaparilla / Purple Twining-pea												X

Family	Scientific Name	Common Name	Exotic	Q1	Q2	Q3	Q4	Q5	Q6	Incidentals Lot 1 DP 624217	Cooperbung Drive	Rodeo Drive	Ravenswood Road	Ravenswood Road lower slopes
FABACEAE	*Hovea linearis*	Rusty Pods			1									
FABACEAE	*Jacksonia scoparia*	Winged Broom-pea											X	
FABACEAE	*Kennedia rubicunda*	Dusky Coral-pea			1									
FABACEAE	*Pulteneae retusa*	A Bush-pea		1	1			1						
FABACEAE	*Pulteneae villosa*	Hairy Bush-pea											X	
FABACEAE	*Trifolium subterraneum*	Subterraneum Clover	Yes											X
GOODENIACEAE	*Goodenia bellidifolia*	Daisy-leaved Goodenia						2						
GOODENIACEAE	*Goodenia hederacea*	Ivy Goodenia		2				2						
GOODENIACEAE	*Goodenia rotundifolia*	-												X
HALORAGACEAE	*Gonocarpous teucrioides*	Germander Raspwort		2		2								
HALORAGACEAE	*Gonocarpus tetragynus*	Poverty Raspwort		2		2	2	2						
JUNCACEAE	*Juncus sp*	Rush					2							
JUNCACEAE	*Juncus usitatus*	Common Rush					2							
LAURACEAE	*Cinnamomum camphora*	Camphor Laurel	Yes								X		X	
LAURACEAE	*Endiandra sieberi*	Hard Corkwood										X		
LOBELIACEAE	*Lobelia ancept*	-					1		2					
LOBELIACEAE	*Pratia purpurascens*	White-root		2	2	2		2					X	
LOMANDRACEAE	*Lomandra filiformis var. filiformis*	Iron Grass		2	2			2					X	
LOMANDRACEAE	*Lomandra longifolia*	Spiny-headed Mat-rush		1	3	2	2	2					X	
LOMANDRACEAE	*Lomandra multiflora subsp multiflora*	Mat-rush		2										
LUZURIAGACEAE	*Eustrephus latifolia*	Wombat Berry			1	1								
MALVACEAE	*Sida rhombifolia*	Paddy's Lucerne	Yes										X	
MELIACEAE	*Synoum glandulosum*	Scentless Rosewood				1								
MENISPERMACEAE	*Stephanie japonica*	Snake Vine							2					
MORACEAE	*Ficus coronata*	Creek Sandpaper Fig				1								
MYRSINACEAE	*Myrsine variabilis*	Muttonwood				1								
MYRTACEAE	*Acmena smithii*	Lilly-pilly				1								
MYRTACEAE	*Acmena smithii*	Lilly-Pilly									X			
MYRTACEAE	*Babingtonia similis*	-		2	2		4	4						
MYRTACEAE	*Baeckea linifolia*	Swamp Baeckea			1	2								

Family	Scientific Name	Common Name	Exotic	Q1	Q2	Q3	Q4	Q5	Q6	Incidentals Lot 1 DP 624217	Cooperbung Drive	Rodeo Drive	Ravenswood Road	Ravenswood Road lower slopes
MYRTACEAE	*Baeckea linifolia*	Weeping / Swamp Baeckea			2									
MYRTACEAE	*Callistemon salignus*	Willow Bottlebrush		2	2	3	2	2					X	
MYRTACEAE	*Corymbia intermedia*	Pink Bloodwood		2	2		2	1			X	X	X	
MYRTACEAE	*Eucalyptus carnea*	Broad-leaf White Mahogany		3									X	
MYRTACEAE	*Eucalyptus crebra*	Narrow-leaf Ironbark										X	X	
MYRTACEAE	*Eucalyptus globoidea*	White Stringybark			4			2				X		X
MYRTACEAE	*Eucalyptus microcorys*	Tallow-wood		1	2	2	3				X	X		
MYRTACEAE	*Eucalyptus pilularis*	Blackbutt			1								X	
MYRTACEAE	*Eucalyptus propinqua*	Small-fruited Grey-gum		2				2				X	X	
MYRTACEAE	*Eucalyptus resinifera*	Red Mahogany		1		2						X		
MYRTACEAE	*Eucalyptus robusta*	Swamp Mahogany						1						
MYRTACEAE	*Eucalyptus saligna*	Sydney Blue gum										X		X
MYRTACEAE	*Eucalyptus seeana*	Narrow-leaf Red-gum		2										
MYRTACEAE	*Eucalyptus siderophloia*	Northern Grey-gum					1							
MYRTACEAE	*Eucalyptus tereticornis*	Forest Red-gum					2	3			X			X
MYRTACEAE	*Leptospermum polygalifolium*	Tantoon			1		2							
MYRTACEAE	*Melaleuca linearifolia*	Snow-in-summer		1						X	X			
MYRTACEAE	*Melaleuca nodosa*	Ball Honey-myrtle		1										X
MYRTACEAE	*Melaleuca quinquenervia*	Broad-leaved Paperbark						5						
MYRTACEAE	*Melaleuca styphelioides*	Prickly-leaved Paperbark				2	2	2						
MYRTACEAE	*Syncarpia glomulifera*	Turpentine			2	4	2							
OLEACEAE	*Notelaea longifolia*	Large Mock-olive											X	
ORCHIDACEAE	*Cryptostylis subulata*	Large Tongue-orchid				1								
OXALIDACEAE	*Oxalis perennans*	-		2			2	2						
PASSIFLORACEAE	*Passiflora edulis*	Common Passionfruit	Yes	1		1								
PHORMIACEAE	*Dianella caerulea*	Blue Flax-lily		2	2		2	2		X			X	
PHORMIACEAE	*Dianella sp*	Flax-lily				2								
PITTOSPORACEAE	*Billardiera scandens*	Apple Dumplings		2	2									
PITTOSPORACEAE	*Pittosporum sp*	-				2								

Family	Scientific Name	Common Name	Exotic	Q1	Q2	Q3	Q4	Q5	Q6	Incidentals Lot 1 DP 624217	Cooperbung Drive	Rodeo Drive	Ravenswood Road	Ravenswood Road lower slopes
PLANTAGINACEAE	*Plantago lanceolata*	Plantain	Yes										X	
POACEAE	*Andropogon virginicus*	Whisky Grass	Yes		2		2	2					X	
POACEAE	*Aristida ramosa*	Three-awned Grass			2									
POACEAE	*Avena fatua*	Wild Oats	Yes										X	
POACEAE	*Briza maxima*	Quaking Grass	Yes										X	
POACEAE	*Bromus cartharticus*	Prairie Grass	Yes								X			
POACEAE	*Chloris gayana*	Rhodes Grass	Yes										X	
POACEAE	*Chloris truncata*	Windmill Grass	Yes								X	X	X	
POACEAE	*Cynodon dactylon*	Couch	Yes							X				
POACEAE	*Dichelachne crinita*	Longhair Plumegrass												X
POACEAE	*Dichelachne micrantha*	Shorthair Plumegrass			1									
POACEAE	*Digitaria sp*	-		2	2	2								
POACEAE	*Entolasia marginata*	Bordered Panic								3				
POACEAE	*Entolasia stricta*	Wiry Panic		2	2	2	5	5					X	
POACEAE	*Imperata cylindrica*	Blady Grass			1						X	X	X	
POACEAE	*Microlaena stipoides*	Weeping Grass			2				2					X
POACEAE	*Oplismenus aemulus*	Basket Grass / Broad-leaf Beard-grass		2	2	4	2	2	5				X	
POACEAE	*Oplismenus imbecillis*	Basket Grass / Broad-leaf Beard-grass				2		2						
POACEAE	*Panicum queenslandicum var. queenslandicum*	Guinea Grass						2						
POACEAE	*Paspalidium distans*	-		1										
POACEAE	*Paspalum urvillei*	Tall Paspalum / Vasey Grass	Yes				2		5					
POACEAE	*Sporobolus fertilis*	Giant Parramatta Grass	Yes										X	
POACEAE	*Themeda australis*	Kangaroo Grass		2	3		2	2				X	X	
POLYGALACEAE	*Comesperma ericinum*	Match Heads						1						
PROTEACEAE	*Banksia spinosa*	Hill Banksia		1										
PROTEACEAE	*Banksia spinulosa var. collina*	Hill Banksia			1									
PROTEACEAE	*Lomatia silaifolia*	Crinkle Bush			1									
PROTEACEAE	*Persoonia katerae*	-			1	1								

Family	Scientific Name	Common Name	Exotic	Q1	Q2	Q3	Q4	Q5	Q6	Incidentals Lot 1 DP 624217	Cooperbung Drive	Rodeo Drive	Ravenswood Road	Ravenswood Road lower slopes
RHAMNACEAE	*Alphitonia excelsa*	Red Ash								X				
RUBIACEAE	*Opercularia aspera*	Stink weed		2	2									
RUBIACEAE	*Pomax umbellata*	Pomax		2										
RUTACEAE	*Acronychia oblongifolia*	Common Acronychia								X				
SANTALACEAE	*Exocarpos cupressiformis*	Cherry Ballard										X		X
SAPINDACEAE	*Dodonea triquetra*	Common Hopbush				1								
SCROPHULARIACEAE	*Veronica notabilis*	Forest Speedwell			2									
SINOPTERIDACEAE	*Cheilanthes sieberi*	Mulga Fern		1										
SINOPTERIDACEAE	*Cheilanthes sieberi subsp sieberi*	Mulga Fern		2										
SOLANACEAE	*Solanum mauritianum*	Wild Tobacco-bush										X		
SOLANACEAE	*Solanum sp*	-								X				
SOLANACEAE	*Solanum nigrum*	Blackberry Nightshade	Yes								X			
VERBENACEAE	*Lantana camara*	Lantana	Yes		2	2	2		2		X	X		X
VERBENACEAE	*Verbena bonarienensis*	Purpletop	Yes										X	
VIOLACEAE	*Viola betonicifolia*	Purple Violet			1					X				
VIOLACEAE	*Viola hederacea*	Ivy-leaved Violet				2	2	2	2					
VITACEAE	*Cissus antarctica*	Kangaroo Grape		1	1									
XANTHORRHOEACEAE	*Xanthorrhoea latifolia*	-											X	

Cover Abundance Key

One individual = 1

0-5% cover = 2

6-15% cover = 3

16-25% cover = 4

26-50% cover = 5

51-75% cover = 6

76-100% cover = 7

X = incidental record

Appendix E

Fauna species recorded in the study area

Table E1 Recorded fauna – combined results

Family	Scientific Name	Common Name	TSC Act	EPBC Act
MAMMALS				
DASYURIDAE	*Antechinus stuartii*	Brown Antechinus		
DASYURIDAE	*Antechinus swainsonii*	Dusky Antechinus		
MACROPODIDAE	*Macropus giganteus*	Eastern Grey Kangaroo		
MACROPODIDAE	*Macropus rufogriseus*	Red-necked Wallaby		
MOLOSSIDAE	***Mormopterus norfolkensis***	**East-coast Freetail Bat**	**Vulnerable**	
MOLOSSIDAE	*Mormopterus sp unk*	-		
MOLOSSIDAE	*Mormopterus sp. 2*	-		
MURIDAE	*Rattus fuscipes*	Bush Rat		
PHALANGERIDAE	*Trichosurus vulpecula*	Common Brushtail Possum		
PSEUDOCHEIRIDAE	*Pseudocheirus peregrinus*	Common Ringtail Possum		
PSEUDOCHEIRIDAE	**Pteropus poliocephalus**	**Grey-headed Flying-fox**	**Vulnerable**	**Vulnerable**
RHINOLOPHIDAE	*Rhinolophus megaphyllus*	Eastern Horseshoe Bat		
VESPERTILIONIDAE	*Chalinolobus morio*	Chocolate Wattled Bat		
VESPERTILIONIDAE	***Chalinolobus nigrogriseus***	**Hoary Wattled Bat**	**Vulnerable**	
VESPERTILIONIDAE	***Falsistrellus tasmaniensis***	**Eastern False Pipistrelle**	**Vulnerable**	
VESPERTILIONIDAE	***Miniopterus australis***	**Little Bent-wing Bat**	**Vulnerable**	
VESPERTILIONIDAE	***Miniopterus schreibersii oceanensis***	**Eastern Bent-wing Bat**	**Vulnerable**	
VESPERTILIONIDAE	*Nyctophilus gouldi*	Gould's Long-eared Bat		
VESPERTILIONIDAE	*Nyctophilus sp*	Longear Bat		
VESPERTILIONIDAE	***Scoteanax rueppellii***	**Greater Broad-nosed Bat**	**Vulnerable**	
VESPERTILIONIDAE	*Scotorepens orion*	Eastern Broad-nosed Bat		
VESPERTILIONIDAE	*Nyctinomus australis*	White-striped Freetail Bat		
VESPERTILIONIDAE	*Vespadelus pumilis*	Eastern Forest Bat		
VESPERTILIONIDAE	*Vespadelus vulturnus*	Little Forest Bat		

Family	Scientific Name	Common Name	TSC Act	EPBC Act
BIRDS				
ACCIPITRIDAE	*Eudynamys scolopacea*	Common Koel		
ALCEDINIDAE	*Elanus axillaris*	Black-shouldered Kite		
ALCEDINIDAE	*Trichoglossus haematodus*	Rainbow Lorikeet		
ARDEIDAE	*Chenonetta jubata*	Australian wood duck		
ARTAMIDAE	*Cacatua roseicapillus*	Galah		
ARTAMIDAE	*Cracticus torquatus*	Grey Butcherbird		
ARTAMIDAE	*Cuculus pallidus*	Pallid Cuckoo		
ARTAMIDAE	*Hirundo neoxena*	Welcome Swallow		
ARTAMIDAE	*Todiramphus sanctus*	Sacred Kingfisher		
CACATUIDAE	*Cacomantis flabelliformis*	Fan-tailed Cuckoo		
CACATUIDAE	*Colluricincla harmonica*	Grey Shrike-thrush		
CAMPEPHAGIDAE	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		
CAMPEPHAGIDAE	*Corvus coronoides*	Australian Raven		
CHARADRIIDAE	*Ixobrychus flavicollis*	Black bitten		
CINCLOSOMATIDAE	*Ptilonorhynchus violaceus*	Satin Bowerbird		
COLUMBIDAE	*Malurus cyaneus*	Superb Fairy-wren		
COLUMBIDAE	*Philemon corniculatus*	Noisy Friarbird		
CORVIDAE	*Corvus orru*	Torresian Crow		
CORVIDAE	*Cracticus nigrogularis*	Pied Butcherbird		
CUCULIDAE	*Calyptorhynchus funereus*	Yellow-tailed Black-cockatoo		
CUCULIDAE	*Dacelo novaeguineae*	Laughing Kookaburra		
CUCULIDAE	*Gerygone olivacea*	White-throated Gerygone		
DICRURIDAE	*Myiagra rubecula*	Leaden Flycatcher		
DICRURIDAE	*Neochmia temporalis*	Red-browed Finch		
DICRURIDAE	*Rhipidura leucophrys*	Willie Wagtail		
DICRURIDAE	*Smicrornis brevirostris*	Weebill		
HIRUNDINIDAE	*Lichenostomus chrysops*	Yellow-faced Honeyeater		
MALURIDAE	*Manorina melanocephala*	Noisy Miner		

Family	Scientific Name	Common Name	TSC Act	EPBC Act
MELIPHAGIDAE	*Alisterus scapularis*	Australian King Parrot		
MELIPHAGIDAE	*Artamus cinereus*	Black-faced Wood-swallow		
MELIPHAGIDAE	*Lichenostomus penicillatus*	White-plumed honey eater		
MELIPHAGIDAE	*Macropygia amboinensis*	Brown Cuckoo-dove		
MELIPHAGIDAE	*Meliphaga lewinii*	Lewins Honeyeater		
MELIPHAGIDAE	*Myiagra cyanoleuca*	Satin Flycatcher		**Migratory**
MELIPHAGIDAE	*Phylidonyris nigra*	White-cheeked Honeyeater		
MELIPHAGIDAE	*Psophodes olivaceus*	Eastern Whipbird		
ORIOLIDAE	*Pachycephala pectoralis*	Golden Whistler		
PACHYCEPHALIDAE	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		
PACHYCEPHALIDAE	*Pachycephala rufiventris*	Rufus Whistler		
PACHYCEPHALIDAE	*Pardalotus punctatus*	Spotted Pardalote		
PARDALOTIDAE	*Acanthiza pusilla*	Brown Thornbill		
PARDALOTIDAE	*Acanthorhynchus tenuirostris*	Eastern Spinebill		
PARDALOTIDAE	*Gallinula tenebrosa*	Dusky moorhen		
PARDALOTIDAE	*Phaps chalcoptera*	Common bronzewing		
PARDALOTIDAE	*Strepera graculina*	Pied Currawong		
PASSERIDAE	*Oriolus sagittatus*	Olive-backed Oriole		
PSITTACIDAE	*Anthochaera chrysoptera*	Little Wattlebird		
PSITTACIDAE	*Vanellus miles*	Masked Lapwing		
PTILONORHYNCHIDA	*Rhipidura fuliginosa*	Grey Fantail		
RALLIDAE	*Gymnorhina tibicen*	Australian Magpie		
SCOLOPACIDAE	*Gallinago hardwickii*	Latham's Snipe		**Migratory**
FROGS				
HYLIDAE	*Litoria caerulea*	Green Tree Frog		
HYLIDAE	*Litoria dentata*	Bleating Tree Frog		
HYLIDAE	*Litoria fallax*	Eastern Dwarf Tree Frog		
HYLIDAE	*Litoria peronii*	Peron’s Tree Frog		
HYLIDAE	*Litoria tyleri*	Tyler’s Tree Frog		

Family	Scientific Name	Common Name	TSC Act	EPBC Act
MYOBATRACHIDAE	*Crinia signifera*	Common Eastern Froglet		
MYOBATRACHIDAE	*Limnodynastes peronii*	Brown Striped Marsh Frog		
MYOBATRACHIDAE	*Pseudophryne coriacea*	Red-braked Toadlet		
MYOBATRACHIDAE	*Uperoleia laevigata*	Smooth Toadlet		
REPTILES				
VARANIDAE	*Varanus varius*	Lace Monitor		
AGAMIDAE	*Physignathus lesueurii*	Eastern Water Dragon		
SCINCIDAE	*Lampropholis delicata*	Sunskink		
FISH				
ELEOTRIDIDAE	*Gobiomorphus australis*	Striped gudgeon		
ELEOTRIDIDAE	*Hypseleotris compressa*	Empire gudgeon		
ELEOTRIDIDAE	*Hypseleotris galii*	Firetail gudgeon		

Appendix F

Assessment of likelihood of threatened species occurring in the study area

Table E1 Threatened fauna – assessment of likelihood of occurrence within the study area

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Birds										
Australasian bittern (*Botaurus poiciloptilus*)	Endangered	-	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha spp*.) and spikerushes (*Eleoacharis spp.*). Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds.	Possible	-	Y	Moderate	Unlikely to displace local population	No	√
Australian painted snipe (*Rostratula australis*)	Vulnerable	Endangered	Permanent and temporary shallow inland and coastal wetlands (can be freshwater or brackish), particularly where there is a cover of vegetation. Individuals have been known to use artificial wetlands such as sewage ponds, dams and water-logged grasslands.	N	-	Y	Low	Unlikely to displace local population	No	√
Barking owl (*Ninox connivens*)	Vulnerable		Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as acacia and casuarina species, or the dense clumps of canopy leaves in large eucalypts. Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Live alone or in pairs. Territories range from 30 to 200 hectares and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts.	Y	Y	Y	Low	Unlikely to displace local population	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Barred cuckoo-shrike (*Coracina lineata*)	Vulnerable		Occurs in subtropical rainforest, wet sclerophyll forest and neighbouring eucalypt forest. Feeds predominantly on fruit and seeds and will frequent isolated fruiting trees. Limited habitat available within the study area.	N	-	Y	Potential visitor	Unlikely to disrupt breeding cycle	No	√
Beach stone-curlew (*Esacus neglectus*)	Critically Endangered		Inhabits open, undisturbed beaches, islands, reefs and estuarine intertidal sandflats and mudflats. Prefers beaches with estuaries or mangroves nearby. Also known to frequent river mouths, offshore sandbars and rock platforms.	N	-	Y	Unlikely	N/A	No	-
Black bittern (*Ixobrychus flavicollis*)	Vulnerable		Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night. During the day, roosts in trees or on the ground amongst dense reeds. Generally solitary, but occurs in pairs during the breeding season, from December to March. Like other bitterns, but unlike most herons, nesting is solitary. Nests, built in spring are located on a branch overhanging water and consist of a bed of sticks and reeds on a base of larger sticks.	Possible	-	Y	Low	Unlikely to displace local population	No	√
Black-breasted buzzard (*Hamirostra melanosternon*)	Vulnerable		Found in a range of inland habitats, including open woodlands and savannas. Will also hunt over grasslands and sparsely timbered woodlands. Timbered watercourses are the preferred breeding habitat. Very rare on the coastal plains of NSW	N	-	N	Unlikely	N/A	N/A	-

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Black-necked stork (*Ephippiorhyncus asiaticus*)	Endangered		Inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey including fish, frogs, eels, turtles, crabs and snakes. Breeds in late summer in the north, and early summer further south. A large nest, up to 2 m in diameter, is made in a live or dead tree, in or near a freshwater swamp.	N	-	Y	Low	N/A	N/A	√
Blue-billed duck (*Oxyura australis*)	Vulnerable		The blue-billed duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. Blue-billed ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. Blue-billed ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer.	N	-	N	Unlikely	N/A	N/A	-
Brolga (*Grus rubicundus*)			Inhabits wetland areas, including shallow swamps, grassy plains, coastal mudflats and irrigated agricultural land. Will also feed in dry grassland and ploughed paddocks and is occasionally observed in mangroves or estuary areas.	N	-	Y	Unlikely	N/A	N/A	-

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Brown treecreeper (*Climacteris picumnus*)	Vulnerable		Found in eucalypt woodlands (including box-gum woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. Usually not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. Sedentary, considered to be resident in many locations throughout its range. Gregarious and usually observed in pairs or small groups of eight to 12 birds. Terrestrial and arboreal in about equal proportions Active, noisy and conspicuous while foraging on trunks and branches of trees and amongst fallen timber; spend much more time foraging on the ground and fallen logs than other treecreepers. Up to 80% of the diet is comprised of ants, with other invertebrates making up the remainder. Hollows in standing dead or live trees and tree stumps are essential for nesting. Although potential habitat occurs few records could be found for the locality. More likely to occur further to the west.	Y	-	Y	Unlikely	N/A	N/A	-
Bush stone-curlew (*Burhinus grallarius*)	Endangered		Lightly-timbered open-forest or woodland often associated with casuarinas, eucalypts or acacias. Also found in dry open grassland and cropland with nearby cover. Although potential habitat occurs no records could be found for the locality. Although an unlikely species, it was targeted during field surveys.	Y	-	Y	Unlikely	N/A	N/A	-
Comb-crested jacana (*Irediparra gallinacea*)	Vulnerable		Inhabits permanent wetlands with a good surface cover of floating vegetation, especially water-lilies. Pairs and family groups forage across floating vegetation. They feed primarily on insects and other invertebrates, as well as some seeds and other vegetation. Breeds in spring and summer in NSW, in a nest of floating vegetation. Potential habitat within the preferred route is limited to a small wetland around Fernbank Creek.	N	-	Y	Unlikely	N/A	N/A	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Little eagle *(Hieracctus morphoides)*	Vulnerable		Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	Y	Y	Y	Moderate	Unlikely to displace local population	No	
Little lorikeet *(Glosspsitta pusilla)*	Vulnerable		Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophoras, Melaleucas and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.	Y	Y	Y	Moderate	Unlikely to displace local population	No	
Freckled duck (*Stictonetta naevosa*)	Vulnerable		Prefer 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. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates.	N	-	N	Unlikely	N/A	N/A	-
Flame robin (*Petroica phoenicea*)	Vulnerable		Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. Prefers clearings or areas with open understoreys.	N		N	Unlikely	N/A	N/A	
Flesh-footed shearwater *(Puffinus carneipes)*	Vulnerable		Marine species. Breeds on Lord Howe Island.	N	-	N	Unlikely	N/A	N/A	

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Glossy black-cockatoo (*Calyptorhynchus lathami*)	Vulnerable		Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly black she-oak (*Allocasuarina littoralis*), forest she-oak (*A. torulosa*) or drooping she-oak (*A. verticillata*) occur. In the Riverina area, inhabits open woodlands dominated by belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites.	Y	Y	Y	Moderate	No nest trees recorded in the study area	No	√
Grass owl (*Tyto capensis*)	Vulnerable		Found in areas of tall grass, including swampy areas, grassy plains and heath. Also found in areas of tall sedges on floodplains. Roost and nest on trampled down platforms of grass.	Y	Y	Y	Low	Unlikely to occur in study area. Unlikely to affect lifecycle	No	√
Grey-crowned babbler (*Pomatostomus temporalis*)	Vulnerable		Inhabits open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer. May also be observed along streams in cleared areas and grassy road verges. Conspicuous large communal nests/roosts are constructed out of twigs. Raucous groups of 2-13 individuals foraging for insects in all substrates.	Y	Y	Y	Unlikely	Unlikely to occur in study area. Unlikely to affect lifecycle	No	√
Hooded robin (*Melanodryas cucullata*)	Vulnerable		Prefers open areas adjacent to large blocks of woodland, particularly with areas of dead timber and sparse shrub cover. Also recorded in open forests and acacia shrublands. Although potential habitat occurs only one old record could be found for the locality.	N	Y	Y	Unlikely	N/A	N/A	-
Marbled frogmouth (*Podargus ocellatus*)	Vulnerable		Subtropical lowland rainforest at altitudes up to 800m, particularly deep, wet, sheltered gullies containing bangalow palms. Also occurs at higher elevations in temperate rainforest and wet eucalypt forest with a rainforest understorey. The study locality is outside of the recognised distribution for this species therefore the one record available is considered dubious.	N	N	N	Unlikely	N/A	N/A	-
Masked booby *(Sula dactylatra)*	Vulnerable		Marine species.	N	N	N	Unlikely	N/A	N/A	

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Masked owl (*Tyto novaehollandiae*)	Vulnerable		Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Y	Y	Y	High (recorded in previous studies)	Unlikely to displace local population	No	√
Olive whistler (*Pachycephala olivacea*)			Found in a range of habitats including rainforest, wet forests and woodlands where riparian vegetation occurs. The olive whistler is regarded as largely sedentary, though partial migration to lower altitudes during winter has been observed. Breeding is generally restricted to areas above 1000m asl.	N	-	N	Unlikely	N/A	N/A	-
Osprey (*Pandion haliaetus*)	Vulnerable	Migratory	Highly specialised fish catcher inhabiting coastal areas. Nests in trees, rocky outcrops, on the ground or in artificial towers (eg. electricity towers).	Y	Y	Y	High (recorded in previous studies)	No nest sites observed or known to occur. Unlikely to affect foraging habitat.	No	√
Painted honeyeater (*Grantiella picta*)	Vulnerable		Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus *Amyema*. Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches. Very rare visitor to the coastal plains of NSW	N	-	Y	Unlikely	N/A	N/A	-
Pied ostercatcher *(Haematopus longirostris)*	Endangered		Found in intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish.	N	N	N	Unlikely	N/A	N/A	

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Powerful owl (*Ninox strenua*)	Vulnerable		The powerful owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The powerful owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as turpentine *Syncarpia glomulifera*, black she-oak *Allocasuarina littoralis*, blackwood *Acacia melanoxylon*, rough-barked apple *Angorphora floribunda*, cherry ballart *Exocarpus cupressiformis* and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the greater glider, common ringtail possum and sugar glider. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. Pairs of powerful owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. powerful owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	Y	Y	Y	High	Unlikely to displace local population	No	√
Regent honeyeater (*Xanthomyza phrygia*)	Critically Endangered	Endangered / Migratory	Box-ironbark eucalypt associations, though uses other woodland types and wet lowland coastal forest in times of food shortage. The wandering nature of this species makes it difficult to assess. Known to frequent areas with densely blossoming winter-flowering trees (e.g. spotted gum, red ironbark, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW.	N	-	Y	High	Opportunistic winter visitor to study area. No core habitat within study area	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Rose-crowned fruit-dove (*Ptilinopus regina*)	Vulnerable		This fruit-dove mainly utilises sub-tropical and dry rainforest and will occasionally visit moist eucalypt, swamp forest or mangroves if food is abundant. The rose-crowned fruit-dove is a fruit specialist and forages on fruiting vines, shrubs, trees and palms. The rose-crowned fruit-dove will also forage from introduced flora species (e.g. camphor laurel). It appears that this species is nomadic / migratory to some degree following fruit availability. This dove nests on a small twig platform in a bush or low tree, with a single egg.	N	-	Y	Moderate (recorded in previous studies)	Opportunistic visitor to study area.	No	√
Rufus scrub-bird *(Atrichornis rufescens)*	Vulnerable		The species is now generally only found in high-rainfall areas above 600 metres above sea level, but formerly occurred in lowland habitats of the Richmond and Tweed River basins.	N	-	N	Unlikely	N/A	N/A	
Scarlet robin *(Petroica boodang)*	Vulnerable		The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat.	N	-	N	Unlikely	N/A	N/A	
Sooty owl (*Tyto tenebricosa*)	Vulnerable		Large areas of tall open forest and woodland particularly in and around dense creek and gully areas. Nests in large hollows in rainforest trees and eucalypts.	Y	Y	Y	Moderate (recorded in previous studies)	Unlikely to displace local population	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Speckled warbler (*Pyrrholaemus sagittatus*)	Vulnerable		The speckled warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. More likely to occur further to the west of the study locality.	N	-	Y	Unlikely	N/A	N/A	-
Square-tailed kite (*Lophoictinia isura*)	Vulnerable		Specialised canopy predator, feeding on small birds, eggs and insects. Primarily hunts over open forest, woodlands and mallee communities that are rich in passerines, as well as over adjacent heaths and other low scrubby habitats and in wooded towns. Appears to prefer a structurally diverse landscape.	Y	Y	Y	High (recorded in previous studies)	Unlikely to displace local population. No nests observed in study area	No	√
Superb fruit-dove (*Ptilinopus superbus*)	Vulnerable		Rainforest or closed forest with fleshy fruit resources. Also may forage in eucalypt or acacia woodland where fruit-bearing trees occur. Limited habitat within the study area.	N	Y	Y	Low	Opportunistic visitor to study area.	No	√
Swift parrot (*Lathamus discolor*)	Endangered	Endangered / Migratory	The migratory nature of this species makes them difficult to assess. Known to frequent sclerophyll forest and woodlands with winter flowering trees (eg. spotted gum, red ironbark, Eucalyptus crebra and *E. siderophloia*, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW	N	Y	Y	High	Opportunistic winter visitor to study are. No core habitat within study area.	No	√
Turquoise parrot *(Neophema pulchella)*	Vulnerable		Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland	N	-	N	Unlikely	N/A	N/A	

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Varied sittella *(Daphoenositta chrysoptera)*	Vulnerable		Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Y	Y	Y	High	Unlikely to displace local population	No	
Wompoo fruit-dove (*Ptilinopus magnificus*)	Vulnerable		Lowland rainforest, moist eucalypt forest and brush box forest that provides fleshy fruit resources. Rare south of Coffs Harbour.	N	Y	Y	Low	Unlikely to affect lifecycle	No	√
Estuary birds that may extend to freshwater habitats										
Greater sand plover (*Charadrius leschenaultii*)	Vulnerable		Sheltered sandy beaches and coastal mudflats. Also sandy cays and reef platforms. Occasionally coastal salt marsh, brackish or freshwater wetlands.	N	-	Y	Unlikely	N/A	N/A	-
Lesser sand plover (*Charadrius mongolus*)	Vulnerable		The lesser sand plover uses beaches in sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats. These plovers often stay in flocks, often sharing roosting and feeding sites with other waders. Suitable roost sites include sandy beaches, spits and rocky shores. Insects, crustaceans, molluscs and marine worms form the diet for the lesser sand plover.	N	-	N	Unlikely	N/A	N/A	-
Little tern (*Sterna albifrons*)	Endangered		Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers. Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands. May occasionally forage along the tidal sections of the Hastings and Wilson Rivers	N	-	Y	Unlikely	N/A	N/A	-
Sooty oystercatcher *(Haematopus fuliginosus)*	Vulnerable		Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries.	N	N	N	Unlikely	N/A	N/A	

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Terek sandpiper (*Xenus cinereus*)	Vulnerable		The terek sandpiper has been recorded in Coastal mudflats, lagoons, creeks and estuaries, with a preference for mangroves. Worms, crustaceans, small shellfish, flies, beetles and water bugs are all included in the varied diet of this sandpiper. Sandpipers feed whilst walking and pecking and probing with their beak into soft, wet mud catching prey.	N	-	Y	Unlikely	N/A	N/A	-
Frogs										
Giant barred frog (*Mixophyes iteratus*)	Endangered	Endangered	Giant barred frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. Tadpoles grow to a length of 80 mm and take up to 14 months before changing into frogs. When not breeding the frogs disperse hundreds of metres away from streams. They feed primarily on large insects and spiders.	Y	-	Y	Moderate (recorded in previous studies)	Unlikely to displace local population	No	√
Green and golden bell frog (*Litoria aurea*)	Endangered	Vulnerable	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as plague minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. Preyed upon by various wading birds and snakes.	Y	-	Y	Low	Unlikely to occur in study area. Unlikely to affect lifecycle	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Green-thighed frog (*Litoria brevipalmata*)	Vulnerable		Rainforest and wet sclerophyll forest, with breeding aggregations also occurring around grassy semi-permanent pools in uneven ground in paperbark forests.	Y	-	Y	High	Mitigation measures would ameliorate impacts	No	√
Sphagnum frog (*Philoria sphagnicolus*)	Vulnerable		Found in rainforests, including Antarctic Beech forest, moist eucalypt forest and sphagnum moss beds, usually at higher elevations. The species burrows in loose, moist soil or moss, under leaf litter often in soaks or seepages, or may use cracks and cavities behind and beside large or small waterfalls where the environment remains saturated with moisture.	N	N	N	Unlikely	N/A	N/A	
Stuttering frog (*Mixophyes balbus*)	Endangered	Vulnerable	Terrestrial inhabitant of rainforest, Antarctic beech or wet sclerophyll forest along permanent streams. Avoids still water localities and areas where stream-side vegetation has been removed. Preys on insects and small frogs along riparian corridors and on the forest floor.	Possible	-	Y	low	Unlikely to displace local population	No	√
Wallum froglet (*Crinia tinnula*)	Vulnerable		Found in acid paperbark swamps, sedge and wet heath of the coastal 'wallum' country. The wallum froglet breeds in winter after heavy rain.	Y	-	Y	Low	Unlikely to affect lifecycle	No	√
Reptiles										
Pale-headed snake (*Hoplocephalus bitorquatus*)	Vulnerable		Nocturnal and partly arboreal snake inhabiting a range of habitats from rainforest and wet sclerophyll forest to drier eucalypt forest. Preferred habitat includes dry hardwood forests and woodlands, particularly in the vicinity of a watercourse. The pale-headed snake appears to require vegetation with old-growth features and is not known to occur in greatly disturbed environments or recently regenerating vegetation. Shelters during the day under loose bark and in the hollow trunks and limbs of dead trees. Predominantly preys on tree frogs, though also takes lizards and small mammals. The habitat within the study area may be too disturbed for this species.	Y	-	Y	High	Unlikely to affect lifecycle	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Stephens' banded snake (*Hoplocephalus stephensii*)	Vulnerable		Partly arboreal in rainforest, wetter sclerophyll forests and rocky areas up to 950m. Shelters during the day under loose bark, among vines, under rock slabs or in hollow trunks, limbs and rock crevices. Hunts for frogs, lizards, birds and small mammals at night.	Y	Y	Y	Moderate	Unlikely to affect lifecycle	No	√
Non-flying terrestrial mammals										
Brush-tailed phascogale (*Phascogale tapoatafa*)	Vulnerable		Found in dry sclerophyll open forests and woodlands, with a preference for sparse ground cover. Also inhabits heath, swamps, rainforest and wet sclerophyll forest. Requires large areas of intact habitat. Nests and shelters in tree hollow.	Y	Y	Y	High (recorded in previous studies)	Mitigation measures would ameliorate impacts		√
Brush-tailed rock-wallaby (*Petrogale penicillata*)	Endangered	Vulnerable	In more recent years this rock-wallaby appears to have become restricted to rock outcrops containing suitable caves and tunnels or very dense undergrowth to provide shelter.	N	-	N	Unlikely	N/A	N/A	-
Common planigale (*Planigale maculata*)	Vulnerable		Inhabits rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is sufficient surface cover. Usually occurs close to water. The common planigale is nocturnal and shelters during the day in nests built in crevices, hollow logs, beneath bark or under rocks. Preys on insects and small vertebrates.	Y	Y	Y	Low	Mitigation measures would ameliorate impacts	No	√
Eastern chestnut mouse (*Psuedomys gracilicaudatus*)	Vulnerable		In NSW the eastern chestnut mouse is mostly found in heathland and is most common in dense wet heath and swampy areas. Has also been recorded from open woodland with a grassy understorey. Population numbers are influenced by fire and it appears to prefer regenerating heathland that has been burnt 18 months to four years previously. In mature heath the numbers of the eastern chestnut mouse drop as the larger swamp rat becomes dominant. Feeds on grass stems, invertebrates, fungi and seeds. Limited potential habitat within the study area	Y	Y	Y	Unlikely	N/A	N/A	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Eastern pigmy possum (*Cercartetus nanus*)	Vulnerable		Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest.	N	N	N	Unlikely	N/A	N/A	
Eastern quoll (*Dasyurus viverrinus*)	Endangered		Variety of habitats including dry sclerophyll forest, scrub, heathland, and cultivated land. In Tasmania individuals are most commonly found where eucalypt forest and pastures are interspersed. Very rare and possibly now extinct on the mainland.	-	-	-	Unlikely	N/A	N/A	-
Emu (*Dromaius novaehollandiae) - endangered population*			On the north coast this species inhabits open forest, woodland, coastal heath, coastal dunes, wetland areas, tea tree plantations and open farmland, and occasionally in littoral rainforest.	-	-	-	Unlikely	N/A	N/A	-
Koala (*Phascolarctos cinereus*)	Vulnerable		Forest and woodland habitats that contain suitable regional eucalypt feed trees. In the locality, the forest red gum and grey gum are listed food trees in SEPP 44.	Y	Y	Y	High (recorded in previous studies)	Unlikely to disrupt breeding cycle	No	√
Long-nosed potoroo (*Potorous tridactylus*)	Vulnerable	Vulnerable	Inhabits coastal heath and dry and wet sclerophyll forests. A relatively thick ground cover is essential and areas with light, sandy soils are preferred.	Y	Y	Y	Low	Unlikely to occur in study area. Unlikely to affect lifecycle	No	√
New Holland mouse *(Pseudomys novaehollandiae)*		Vulnerable	Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.	N	N	N	No potential	Unlikely to occur in study area. Unlikely to affect lifecycle	No	

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Parma wallaby (*Macropus parma*)	Vulnerable		Favours wet sclerophyll forest with a thick, shrubby understorey often with nearby grassy patches, rainforest margins and occasionally drier eucalypt forest. Shelters in dense cover during the day. Feeds during the night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas. No records for the study locality, more likely to occur in the ranges further to the west.	Y	Y	Y	Unlikely	N/A	N/A	-
Rufus bettong (*Aepyprymnus rufescens*)	Vulnerable		Found in a variety of habitats although it prefers open woodland, with a tussock grass understorey. Preferred shelter habitat is a dense cover of tall native grasses. Sleeps during the day in a nest constructed of grass and feeds at night on grasses, herbs, seeds, flowers, roots, tubers, fungi and occasionally insects. Rarely recorded south of Coffs Harbour as preferred habitat is limited.	Y	Y	Y	Unlikely	N/A	N/A	-
Spotted-tailed quoll (*Dasyurus maculatus*)	Vulnerable	Endangered	Inhabits a variety of habitat types from moist and wet sclerophyll through to dry forests and woodlands on the edge of open grasslands. Requires large hollow logs on the ground for den.	Y	Y	Y	High (known to occur in study area)	Habitat restricted to movement corridors between optimal habitat	No	√
Squirrel glider (*Petaurus norfolcensis*)	Vulnerable		Usually inhabits dry open sclerophyll forest and woodlands, but has also been observed in moist regenerating forest and moist gullies. Forages on acacia gum, eucalypt sap, nectar, honeydew, manna invertebrates and pollen, utilising areas with an abundance of flowering eucalypts and tall shrubs (eg. banksias). Acacia species are the preferred sap feeding trees. This species requires an abundance of suitably sized hollow-bearing trees.	Y	Y	Y	High	Mitigation measures would ameliorate impacts	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Yellow-bellied glider (*Petaurus australis*)	Vulnerable		Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Den, often in family groups, in hollows of large trees. Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar.	Y	Y	Y	High (recorded in previous studies)	Mitigation measures would ameliorate impacts	No	√
Flying mammals										
Common blossom bat (*Syconycteris australis*)	Vulnerable		Occurs in coastal areas of north-east NSW and eastern Queensland. Roosts singly within foliage in littoral rainforest. Also known to roost in other forest types containing rainforest elements. The common blossom bat is a specialised nectar feeder and generally feeds in heathland and paperbark swamp on paperbark, bottlebrush, banksia and bloodwood flowers. Also known to feed on banana flowers. Generally changes roost sites daily, though will return to favoured feeding sites on consecutive nights. Most likely to occur closer to the coastal strip within the study locality.	N	N	Y	Unlikely	N/A	N/A	-
Eastern bent-wing bat (*Miniopterus schreibersii oceanensis*)	Vulnerable		Forages within a variety of habitat types including moist and dry eucalypt forest, woodland, rainforest, heath and open environments, including urban areas. Reliant on suitable roosting/breeding habitat in caves and mine tunnels, though will also roost in stormwater channels, road culverts and other comparable structures (including buildings). Estimated nightly foraging range of 20 kilometres.	N	Y	Y	Present (Recorded throughout Study Area)	No suitable breeding habitat	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Eastern freetail-bat (*Mormopterus species*)[undescribed]	Vulnerable		Recorded from a wide range of habitats, including tall open forest, River Red gum and Yellow box woodlands, riparian open forest and dry sclerophyll forest. This species primarily roosts in tree hollows and spouts.	Y	Y	Y	Moderate	Unlikely to displace local population	No	√
Eastern false pipistrelle (*Falsistrellus tasmaniensis*)	Vulnerable		Tall forest, woodland or heath/ grassland edges. Roosts in hollow trunk of the largest trees and sometimes buildings.	Y	Y	Y	Present (Recorded at Cooperabung Drive)	Unlikely to displace local population. Unlikely to disadvantage foraging	No	√
Eastern long-eared bat Nyctophilus bifax	Vulnerable		Species favours wetter habitats, ranging from rainforest and monsoon forests to riverine paperbark forests. May also inhabitat open woodland, tall open forest and dry sclerophyll woodland (Churchill 1998). Will roost under peeling bark, among epiphytes and within tree hollow.	Y	Y	Y	Moderate	Unlikely to displace local population. Unlikely to disadvantage foraging	No	
Golden-tipped bat (*Kerivoula papuensis*)	Vulnerable		Rainforest or rainforest gullies in wet sclerophyll forest. Roosts in scrubwren and gerygone nests. Roost sites limited to dense moist riparian habitat along permanent freshwater creeks within the study area.	Y	Y	Y	Low	Unlikely to displace local population. Unlikely to disadvantage foraging	No	√
Greater broad-nosed bat (*Scoteanax rueppellii*)	Vulnerable		Forages for insects over a range of natural and altered habitats, including tall forest, woodland or heath/grassland edges, often along the tree line boundary. Prefers tree hollows in large, often isolated, mature trees for roosting. Usually associated with tall moist open forest.	Y	Y	Y	Present (Recorded at Cooperabung Drive)	Unlikely to displace local population. Unlikely to disadvantage foraging.		√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Grey-headed flying-fox (*Pteropus poliocephalus*)	Vulnerable	Vulnerable	Regularly occurs along the eastern coastal plain through NSW. Roosts in camps, usually in dense riparian habitats. At dusk disperses in search of the preferred food source, mainly eucalypt blossom and rainforest fruits. Long distances are covered (30+km) in search of food. No permanent or temporary camps are known to occur within the proposed road easement.	N	Y	Y	High	Unlikely to displace the local population. Unlikely to disrupt breeding cycles or roosting behaviour	No	√
Hoary Wattled Bat (Chalinolobus nigrogriseus)	Vulnerable		In NSW the Hoary Wattled Bat occurs in dry open eucalypt forests, favouring forests dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common				Present (Recorded at Stumpy Creek)	Unlikely to displace the local population. Unlikely to disrupt breeding cycles or roosting behaviour	No	
Large-eared pied bat (*Chalinolobus dwyeri*)	Vulnerable	Vulnerable	Range of well-wooded habitats, including dry sclerophyll forests and woodlands of coastal and semi-arid areas. Occasionally in sub-alpine woodlands and at the edge of rainforest and semi-arid areas. Reliant on suitable roosting habitat including caves and mine tunnels (though may use other structures, eg. abandoned fairy martin nests). Most often recorded foraging within forest/woodland adjacent to rocky escarpments.	N	Y	Y	Limited	Unlikely to occur in study area. Unlikely to affect lifecycle	No	√
Little bent-wing bat (*Miniopterus australis*)	Vulnerable		Forages in a range of habitats, including forest, woodland, heath, coastal swamps and rainforest. A nightly foraging range of 20km from roost sites has been reported. Reliant on suitable roosting habitat in caves and mine tunnels, though has been recorded roosting in hollowed out tree bases and dense foliage.	N	Y	Y	Present (Recorded throughout study area, principally Stumpy Creek)	No suitable breeding habitat	No	√

Common name (scientific name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site			Potential to utilise study area	Summary of assessment of significance	Likely significant impact	Subject species
				Breeding	Roosting	Foraging				
Large-footed myotis (*Myotis macropus*)	Vulnerable		Habitats adjacent to large bodies of water for hunting aquatic insects. Usually forages over or adjacent to water-bodies and associated terrestrial habitats. Roosts in caves, mines, tunnels, bridges, culverts and tree hollows.	Y	Y	Y	Recorded	Unlikely to affect foraging activity. Unlikely to lead to extinction of local population.	No	√
Yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*)	Vulnerable		Wide range of habitats, including open forest. Forages above the canopy in wooded areas and lower down in more open areas or along creeklines. Reliant on suitable trees with hollows for roosting. Has a patchy, although widespread, distribution in coastal NSW.	Y	Y	Y	Limited	Unlikely to displace local population. Unlikely to disadvantage foraging	No	√
Invertebrates										
Giant dragonfly (*Petalura gigantea*)	Endangered		Boggy seepages and swamps. The larvae occupy permanent burrows in wetland soils that open above the water level. They emerge from the burrows at night and in wet weather to feed. Most likely to occur in the wetlands of the Hastings and Wilson Rivers mainly to the east of the proposed road easement	Y	Y	Y	Low	Unlikely to occur in study area. Unlikely to affect lifecycle	No	√
Laced fritillary (*Argyreus hyperbius*)	Endangered		Very localised distribution – restricted to open swampy coastal areas where the larval food plant (*Viola betonicifolia*) grows. It occurs from just south of Gympie, Queensland, to just north of Port Macquarie. Most likely to occur closer to the coastal strip.	N	N	Y	Unlikely	N/A	N/A	-

Table F2 Threatened flora – assessment of likelihood of occurrence within the study area

Scientific name (common name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site	Potential to occur within study area	Summary of assessment of significance	Likely significant impact	Subject species
Acronychia littoralis (scented acronychia)	Endangered	Endangered	Littoral rainforest on sand.	Marginal	**No potential–** unconfirmed records in 2 places by HWR Ecological (2005)- GHD relocated samples in same area and found only *Acronychia oblongifolia*	N/A	N/A	Y
Allocasuarina defungens (dwarf heath casuarina)	Endangered	Endangered	Mainly 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.	Marginal	**Low –** no suitable habitat present	N/A	N/A	N
Arthraxon hispidus (hairy-joint grass)	Vulnerable	Vulnerable	Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.	Yes - by creeks, swamps and in moist communities	**Moderate**	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	Y
Chamaesyce psammogeton (sand spurge)	Endangered		Grows on fore-dunes and exposed headlands, often with spinifex (*Spinifex sericeus*).	No	**Low –** no suitable habitat present	N/A	N/A	N
Cynanchum elegans (white-flowered wax plant)	Endangered	Endangered	Usually occurs on the edge of dry rainforest vegetation, rainforest gullies scrub and scree slopes. Other associated vegetation types include littoral rainforest; coastal tea-tree – coastal banksia scrub; forest red gum aligned open forest and woodland; spotted gum aligned open forest and woodland and bracelet honeymyrtle *Melaleuca armillaris* scrub to open scrub.	Possibly in rainforest areas or moist gullies	**Low –** no suitable habitat present	N/A	N/A	N
Cryptostylis hunteriana (leafless tongue-orchid)	Vulnerable	Vulnerable	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	Nominally suitable habitat in some areas.	**Low –** no records for the locality	N/A	N/A	N

Scientific name (common name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site	Potential to occur within study area	Summary of assessment of significance	Likely significant impact	Subject species
Hakea archaeoides (big Nellie hakea)	Vulnerable	Vulnerable	Found on steep, rocky, sheltered slopes and in deep gullies in open eucalypt forest. Commonly occurs at the interface of dry eucalypt forest and gully communities.	Possibly	**Low –** no suitable habitat present	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	N
Hydrocharis dubia (frogbit)	Vulnerable		Grows in small shallow freshwater bodies or swamps.	Possibly	**Low –** potential habitat available but no records for the locality	N/A	N/A	N
Marsdenia longiloba (clear milkvine)	Endangered	Vulnerable	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops.	Possibly	**Low –** no suitable habitat present	N/A	N/A	N
Maundia triglochinoides	Vulnerable		Swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Associated with wetland species e.g. *Triglochin procerum*.	Yes	**Low** Suitable habitat present but only 2 records for the locality.	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	Y
Melaleuca biconvexa (biconvex paperbark)	Vulnerable	Vulnerable	Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	Yes – damp areas associated with streams and floodplains.	**Low**	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	Y
Melaleuca groveana (Grove's paperbark)	Vulnerable		Heath and shrubland, often in exposed sites at high elevations on rocky outcrops and cliffs. It also occurs in dry woodlands.	Unlikely	**Low**	N/A	N/A	N
Oberonia titania (red-flowered king of the fairies)	Vulnerable		Occurs in littoral and subtropical rainforest and paperbark swamps, but it can also occur in eucalypt-forested gorges and in mangroves	Possibly in paperbark swamp, rainforest or moist areas.	**Low** – the sole record for the locality is in the urban area of Port Macquarie and likely to be a garden specimen.	N/A	N/A	N

Scientific name (common name)	TSC Act status	EPBC Act status	Preferred habitat and comments	Habitat available on site	Potential to occur within study area	Summary of assessment of significance	Likely significant impact	Subject species
Parsonsia dorrigoensis (milky silkpod)	Vulnerable	Endangered	Subtropical and warm-temperature rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils. Appears to be able to withstand, and maybe even favour, light to moderate physical disturbance.	Possibly in moist gullies and rainforest areas.	**Low –** no suitable habitat present	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	Y
Phaius australis (southern swamp-orchid)	Endangered	Endangered	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	Possibly in swampy, rainforest or moist areas.	**Low** Nominally suitable habitat available	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	Y
Phaius tankervilleae (swamp-orchid)	Endangered	Endangered	Found in swampy grassland or swampy forest, including rainforest, eucalypt and paperbark forest.	Possibly in swampy, rainforest or moist areas.	**Low** Nominally suitable habitat available	Unlikely to remove fragment, displace or disturb local population. No risk of extinction	No	Y
Quassia sp. Moonee Creek (Moonee quassia)	Endangered	Endangered	Shrubby layer below tall moist eucalypt forest and tall dry eucalypt forest, including forest edges, mostly at lower altitudes.	Nominally suitable habitat in rainforest or moist areas	**Low –** no records for the locality	N/A	N/A	-
Taeniophyllum muelleri (Minute Orchid)		Vulnerable	Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges, from sea level to 250 m alt., north from the Bellinger R	Nominally suitable habitat in rainforest or moist areas	**Low –** nominally suitable habitat available	N/A	N/A	-
Thesium australe (austral toadflax)	Vulnerable	Vulnerable	Occurs in grassland or grassy woodland. Often found in damp sites in association with kangaroo grass.	Nominally suitable habitat in some areas.	**Low –** no records for the locality	N/A	N/A	-

Appendix G

Part 3A assessments of significance

Assessment under Part 3A of the Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) forms the legal and policy platform for development assessment and approval in NSW and aims to, *inter alia*, 'encourage the proper management, development and conservation of natural and artificial resources'. The Proposal has been declared as a project to which Part 3A of the EP&A Act applies. The Proposal requires the approval of the Minister for Planning.

An evaluation of the magnitude, extent and significance of impacts of the Proposal on these threatened flora species and their habitats following the assessment criteria identified in the *Draft Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act* (DEC 2005 and DPI 2005) has been undertaken and is provided below.

Appendix I.1 Assessment of impact on threatened flora species and EECs

An assessment of the impact on threatened flora species and EECs that could possibly occur within the study area is presented below. This section addresses the heads of consideration given in Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* under Part 3A of the *Environmental Planning and Assessment Act 1979* (DEC & DPI 2005), with reference to the relevant sub-headings within each head. It should be noted that at this stage this checklist is part of a draft document, which is yet to be finalised. Therefore, the questions currently have no legal standing and are used here for guidance only.

Threatened flora species and EECs considered for this assessment are:

- *Acronychia littoralis* (scented acronychia).
- *Arthraxon hispidus* (hairy jointgrass).
- *Parsonsia dorrigoensis* (milky silkpod).
- *Phaius australis* (southern swamp orchid).
- *Phaius tancarvilleae* (swamp orchid).
- Swamp Sclerophyll Forest.
- Swamp Oak Floodplain Forest.
- Subtropical Coastal Floodplain Forest.
- Freshwater Wetlands.

a) How is the Proposal likely to affect the lifecycle of a threatened species and/or population?

No threatened flora was recorded during the field surveys. Notwithstanding an assessment of the possible impact of the Proposal on the above five threatened flora species has been undertaken.

The reproduction cycles of threatened flora would only be significantly disrupted if:

- Most or all individuals of a population were removed.
- The population seriously fragmented.
- The habitat that the population relies on is substantially compromised.

Since no threatened flora species were recorded in the study area during field surveys, it is considered unlikely that the Proposal would disturb any population of threatened flora. Impacts on seedbanks of threatened flora species by the Proposal are considered to be unlikely. For the same reason, impacts on pollen cycles of other threatened flora species are considered unlikely. None of the threatened flora species that could occur in the study area have dormancy period mechanisms likely to be significantly disturbed by the Proposal. Within this context it is considered unlikely that any population of threatened flora and their habitat would be significantly impacted by the Proposal.

Unmitigated runoff from the Proposal during both construction and operation could indirectly affect threatened species associated with swamp habitats such as the swamp orchid and southern swamp orchid (if present). Sediment and erosion controls recommended as part of the mitigation measures for control and management of runoff would effectively prevent any significant indirect disturbances.

Other species that would not be directly impacted could be indirectly affected by edge effects and associated weed invasions. Such species could include hairy jointgrass and milky silkpod. Mitigation measures for the control and management of weeds would effectively minimise the potential for adverse indirect impacts on these species.

b) How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

Threatened flora species

Since no threatened flora species were detected in the any of the flora surveys within the Proposal footprint it is considered unlikely that habitat for threatened flora species would be directly affected by the Proposal. In the unlikely event that habitat for any additional threatened species occurs within the zone of direct or indirect impact by the Proposal, the level of impact on the habitat of the species is likely to be minimal in the context of the distribution of habitat in the study locality and regionally.

Disturbances associated with the Proposal could initiate conditions that facilitate invasions of exotic species. Significant weed invasions would also have the potential to degrade the habitat for threatened flora species if present. Threatened plants are highly vulnerable to invasions of introduced weeds, particularly lantana (*Lantana camara*), bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*) and exotic vines (DECC 2008). Invasions of all these species or species groups are listed as key threatening processes on the TSC Act. Lantana is also listed as a notifiable noxious weed under the Noxious Weeds Act, this occurring in patches within the study area. Uncontrolled construction works may also increase the risk of new invasions of exotic vines such as moth plant (*Araujia sericifera*), morning glory and mile-a-minute (*Ipomoea indica* and *I. cairica*) which are known to occur within the study locality.

Runoff of sediment, nutrients and pollutants could also directly impact on potential habitat for threatened species during both the construction and operation phases of the Proposal. Runoff of nutrients could also indirectly initiate a process of weed invasion as discussed above. Targeted management and control of runoff as well as direct control of noxious and environmental weeds is an integral part of the Proposal, during both the construction and operation phases and aim to minimise the potential for adverse indirect impacts on areas of adjoining habitat.

Endangered ecological communities

This area is defined as the region for the purposes of this assessment. The relevant map units from the regional study (NPWS 1999) that are included within each EEC according to the relevant Final Determinations, together with their remaining area as of 1999 and conservation status within the region are given in the table below.

Vegetation communities from NPWS (1999) that correspond to endangered ecological communities in the Proposal footprint

EEC	Corresponding Vegetation Communities (NPWS 1999)		Current Extent (ha)	Cleared Estimate	Status (NPWS 1999)*
	Map Unit No.	Community Name			
Swamp Sclerophyll Forest	112	Paperbark swamp forest.	28577	75%	V, P
	142	Swamp mahogany swamp forest.	578	75%	R, P
Swamp Oak Floodplain Forest	143	Swamp Oak swamp forest.	2883	75%	R, SD, H, P
Subtropical Coastal Floodplain Forest	46	Cabbage gum open forest or woodland.	3002	70%	V
	73	Forest red gum - swamp box.	57016	60%	SD, P
Freshwater Wetlands	141	Coastal freshwater meadows, sedgelands, rushlands and forblands of lagoons and wetlands.	24118	40 – 80%	E, P

*Status: E – Endangered. V – Vulnerable. R – Rare. SD – Severely Depleted. H – Highly Inadequately Reserved. P – Private Land Priority.

All EECs are of high conservation significance in the region covered by NPWS (1999) according to their current status and the estimated extent of habitat that has been cleared. It is difficult to rank the conservation priorities of the EECs on the basis of the status of the communities that make them up, but the EECs that are either noted as 'Endangered' (such as Freshwater Wetlands) or whose current extent is low and 'severely depleted' (such as Swamp Oak Floodplain Forest) are probably most sensitive to loss of habitat. It should be noted that the current extent of Freshwater Wetlands shown below could be an overestimate, since Map Unit 141 includes two vegetation formation types – forested wetlands and freshwater wetlands of which only the latter may strictly correspond to the EEC.

The Proposal would directly remove or modify the following areas of occupied habitat for each of the EECs within the Proposal footprint:

- Swamp Sclerophyll Forest on Coastal Floodplains (1.65 hectares).
- Subtropical Coastal Floodplain Forest (1.23 hectares).
- Freshwater Wetlands (0.11 hectares).
- Swamp Oak Floodplain Forest (0.81 hectares).

Apart from a degree of fragmentation of habitat for Swamp Sclerophyll Forest on Coastal Floodplains, the effect on the total area of habitats for all EECs locally would be minor and limited to localised losses from larger areas of communities that would remain extant locally. The proportion of the remaining area of each EEC within the region that would be affected by the Proposal is given in the table below.

Proportion of the total area of endangered ecological communities in the region that would be affected by the Proposal

EEC	Total Extent of EEC in Region (NPWS 1999) (ha)	Area of EEC Impacted by Proposal in the study area (ha)	Percentage of EEC Impacted in Region
Swamp Sclerophyll Forest	29155	1.7 ha	0.006%
Swamp Oak Floodplain Forest	28833	0.8 ha	0.003%
Subtropical Coastal Floodplain Forest	60018	1.2 ha	0.002%
Freshwater Wetlands	24118	0.1 ha	0.0005%

As the table shows, no more than 0.1 per cent of the total area of any EEC in the region would be removed or modified by the Proposal.

Indirect impacts on EECs from runoff, weed invasion and other degrading processes would increase the area of impact, but not to the extent that a significant proportion of each EEC would be affected regionally.

Disturbances associated with the Proposal could initiate conditions that facilitate invasions of exotic species. Significant weed invasions would also have the potential to degrade the habitat for EECs located adjacent to the Proposal. EECs are highly vulnerable to invasions of introduced weeds, particularly lantana, bitou bush and exotic vines (DECC 2008). Invasions of all these species or species groups are listed as key threatening processes on the TSC Act. Lantana is also listed as a notifiable noxious weed under the NW Act, this occurring in patches within the study area. Uncontrolled construction works may also increase the risk of new invasions of exotic vines such as moth plant (*Araujia sericifera*), morning glory and mile-a-minute (*Ipomoea indica* and *I. cairica*) which are known to occur within the study locality.

Runoff of sediment, nutrients and pollutants could also directly impact on potential habitat for threatened species during both the construction and operation phases of the Proposal. Runoff of nutrients could also indirectly initiate a process of weed invasion as discussed above. Targeted management and control of runoff as well as direct control of noxious and environmental weeds is an integral part of the Proposal, during both the construction and operation phases and aim to minimise the potential for adverse indirect impacts on areas of adjoining habitat.

c) Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

The currently known geographical distributions of threatened and significant species have generally been obtained from the BioNet database of DECCW, Forests NSW and Royal Botanic Gardens records; and other sources as indicated.

Scented acronychia has been recorded along the NSW coast from just south of Port Macquarie in the south, to the Queensland border (in NSW) and beyond in the north. An occurrence of the species in the study area would therefore be approaching (within 10 kilometres of) the southern limit of its currently known distribution.

Hairy jointgrass has been recorded from near Kundabung (within the study area) in the south, to the Queensland border in the north and inland to west of the ranges. The species, if still present in the study area, would therefore be at the southern limit of its currently known distribution.

Milky silkpod has been recorded from Comboyne (north of Taree) in the south to south-west of Grafton in the north. The species, if present in the study area, would therefore not be at the limit of its currently known distribution.

The swamp orchid has been previously recorded on the NSW north coast, north of Iluka. The species, if present in the study area, would therefore be at or beyond the southern limit of its currently known distribution.

The southern swamp orchid has been recorded on the NSW north coast, north of Lake Cathie (south of Port Macquarie). An occurrence of the species in the study area would therefore be approaching (within 20 kilometres of) the southern limit of its currently known distribution.

Therefore there is a chance that the Proposal could affect four species (scented acronychia, hairy Jointgrass, swamp orchid and southern swamp orchid) at or near the southern limit of their known distributions, if they are present in the study area.

d) How is the Proposal likely to affect current disturbance regimes?

A large proportion of the study area adjoins highly disturbed and modified lands influenced by farming, grazing, plantations, quarries, tracks and roadside disturbances. These disturbance regimes have had an influence on the existing environment and may be exacerbated by the Proposal. In areas of limited existing disturbance, the Proposal has the potential to introduce many of the above influences on previously undisturbed habitat such as at Stumpy Creek. Many of these disturbance regimes will remain after the construction of the Proposal.

The effects of current disturbance regimes can be minimised by the use of appropriate ameliorative measures during the construction period such as soil management, including stabilisation and control of runoff and revegetation of bare earth stockpile. Weed control programs, including wash down procedures would also be considered to minimise the spread of weeds into undisturbed bushland. The use of permanent fencing to exclude access to the roadside shoulder would reduce the potential for unanticipated damage to peripheral bushland by the public. Ongoing weed management of the roadside verges is also considered an appropriate long term management process that would reduce the affect of current disturbance regimes.

e) How is the Proposal likely to affect habitat connectivity?

The Proposal is expected to result in the removal of strips of remnant vegetation of varying length from within the study area, including the removal of vegetation from within mapped areas of key habitat and wildlife corridors. This has implications for natural vegetation communities, including endangered ecological communities and threatened flora species habitat.

The proposed route throughout Lot 80 DP 737375 would reduce the size of the remnant and fragment two areas of vegetation identified as the endangered ecological community Swamp Sclerophyll Forest on Coastal Floodplains and Swamp Oak Forest on Coastal Floodplains. Habitat severance at this locality would be addressed by the installation of an incidental fauna crossing principally designed for the movement of frogs and small mammals. Irrespective of this linkage, the severed vegetation remains connected to the floodplain and would therefore not be completely separated from important ecological functions that support the generation and persistence of these communities.

The construction of the Proposal at Stumpy Creek would serve to increase the gap already occurring at this location. An underpass in the form of a bridge already exists at this location however its capacity to connect vegetation either side of the Proposal is substantially limited. Improvements to this bridge crossing in terms of its capacity to allow fauna movements across the Proposal within a mapped regional corridor should be examined to minimise the fragmentation of the Proposal.

In summary, it is considered that the Proposal would contribute to general fragmentation of natural vegetation, including at least two EECs. Exchange of genetic material is still likely to occur between the separate patches across the highway by means of insect, wind and water borne dispersal of pollen, seeds and propagules. Such dispersal mechanisms could be facilitated by retention or planting of some vegetation in the median strip between the two carriageways, to the extent that this does not compromise traffic safety. This strategy would have added benefit for fauna movements.

f) How is the Proposal likely to affect critical habitat?

No areas of critical habitat proclaimed under the TSC Act to date occur in the vicinity of the study area. Critical habitat will not be affected by the Proposal.

Conclusion to Part 3A Assessment for threatened flora and EECs

It is considered unlikely that the Proposal would result in impacts of a magnitude that would cause a local population of threatened flora or local occurrence of an endangered ecological community to become extinct, based on the following:

- No threatened flora was recorded within the Proposal footprint. No threatened flora is expected to be impacted by the Proposal within the study area.
- The Proposal would result in the fragmentation of natural vegetation, including at least two EECs. However, this increase in fragmentation is unlikely to have a significant adverse impact on threatened flora populations or EECs.
- Less than 0.1 per cent of the total area of any EEC in the Mid-North Coast Region of NSW would be removed or modified by the Proposal. Clearing for the Proposal would not be to the extent that a significant proportion of each EEC would be affected regionally.

The impacts of the Proposal are sufficiently large to warrant impact management. Avoidance is proposed through the use of detailed design. This is particularly relevant in areas where there are roadside trees that are able to be conserved. Roadside plantings, weed management and soil and water quality management area also recommended. Offsets for the loss of native vegetation cover are also recommended to achieve a Maintain and Improve outcome.

Appendix I.2 Assessment of impact on threatened fauna

This assessment addresses the potential effects of the Proposal on threatened fauna species or their habitats according to Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* under Part 3A of the EP&A Act (DEC & DPI 2005). Threatened fauna species known or with potential to occur within the study area are listed below. Those species positively identified during surveys within the study area are marked with an asterisk*.

Category	Fauna species
Known or likely to occur within the study area	Black-necked stork, brush-tailed phascogale, common planigale, east-coast freetail-bat*, eastern bent-wing bat*, eastern false pipistrelle*, giant barred frog, glossy black-cockatoo, greater broad-nosed bat*, green-thighed frog, grey-headed flying-fox*, hoary wattled bat*, koala, little bent-wing bat*, masked owl, osprey, powerful owl, rose-crowned fruit-dove, sooty owl, southern myotis, spotted-tailed quoll, square-tailed kite, squirrel glider, yellow-bellied glider.
Potential to occur within the study area	Australasian bittern, Australian painted snipe, barking owl, barred cuckoo-shrike, black bittern, comb-crested jacana, giant dragonfly, golden-tipped bat, grass owl, green and golden bell frog, grey-crowned babbler, large-eared pied bat, long-nosed potoroo, pale-headed snake, regent honeyeater, stephen's banded snake, stuttering frog, superb fruit-dove, swift parrot, wallum froglet, wompoo fruit-dove and yellow-bellied sheathtail-bat.

For the purposes of this report, the subject species have been grouped according to similar behavioural characteristics or habitat requirements and assessed below using the factors given in Appendix 3 of the Part 3A guidelines.

a) How is the Proposal likely to affect the lifecycle of a threatened species and/or endangered population?

The following impact assessment is partitioned into two sections reflect the study area survey results. The first section deals with species that were recorded during the survey period, with the latter dealing with species identified as having potential habitat.

Threatened species recorded during the study area survey

Cave-roosting bats – eastern bent-wing bat (*Miniopterus schreibersii oceanensis*), little bent-wing bat (*Miniopterus australis*) – both vulnerable under the NSW TSC Act and large-eared pied bat (*Chalinolobus dwyeri*) – vulnerable under the NSW TSC Act and Commonwealth EPBC Act

Both bent-wing bat species occur along the coast and ranges of eastern Australia, extending from Cape York, through to the central coast of NSW for the little bent-wing bat and Victoria for the eastern bent-wing bat. Both species are relatively widespread and can be locally common where suitable caves or tunnels are available as roost sites. While caves represent the natural roosting habitat of both the eastern bent-wing bat and the little bent-wing bat, both species will also utilise old mines, stormwater channels, road culverts and other similar structures. The little bent-wing bat is known to occasionally roost in large hollowed-out tree bases or dense foliage (Schulz 1997). The major threat to these cave-roosting bat species is the loss of roost sites, particularly nursery caves. Their dependence upon relatively few nursery caves suggests that threats to the existence or structural integrity of these may place widespread populations in jeopardy (Dwyer 1995). Habitat loss through clearing for development or agriculture and subsequent reductions in insect prey availability may also adversely affect these species.

The large-eared pied bat is found in rocky areas and adjoining forested habitat in the east coast and ranges of NSW and southern Queensland. This species generally roosts in caves and mine shafts where it inhabits the twilight zone and has also been reported to roost in disused fairy martin nests and therefore may roost under bridges and culverts.

The little bent-wing bat forages for insects beneath the canopy in well timbered forest and is also known to forage within coastal swamps and rainforest. A nightly foraging range of 20 kilometres from the roost site has been reported for the little bent-wing bat. Breeding takes place in July and August, with births occurring in December.

The little bent-wing bat was one of the most commonly recorded species, being found throughout the length of the Proposal during the previous surveys (GHD 2010b). Recordings of this species within the study area at Stumpy Creek, Rodeo Drive and Cooperabung Drive confirm these prior findings.

Maternity caves are known in the Yessabah and Willi Willi Caves west of Kempsey where this species is likely to preferentially breed and conduct important lifecycle processes. Accordingly it is unlikely that this species would preferentially breed in roost sites near to the highway route although it is possible that individuals may use temporary roosts nearby during expanding foraging campaigns. Small numbers of this species may seasonally roost under bridges and culverts along the existing road route, with individuals known to roost in the girder gaps of the southbound Maria River road bridge (GHD, 2010a).

The eastern bent-wing bat is known to forage within a variety of habitat types including rainforest, moist and dry eucalypt forest, swamp sclerophyll forest and heath. Dwyer (1995) regards typical habitat as well-timbered valleys, though this species has been reported utilising bushland remnants in urban areas. The eastern bent-wing bat is known to feed on moths, cockroaches, grasshoppers and ants and forages above the tree canopy (AMBS 1995). Like the little bent-wing bat, the eastern bent-wing bat is a mobile species and is estimated to forage within a 20 kilometres radius in a single night.

The eastern bent-wing bat was recorded throughout the length of the Proposal and Rodeo Drive and Cooperabung Drive within the study area. The eastern bent-wing bat was also recorded during supplementary surveys by GHD in November 2007. Maternity caves are known in the Yessabah Caves west of Kempsey, though this species is unlikely to breed in roost sites near to the highway route. Small numbers of this species may seasonally roost under bridges and culverts along the existing road route.

Although known foraging habitat would be cleared or modified as a result of the Proposal, it is unlikely that the eastern bent-wing bat would suffer a significant adverse impact as this species is capable of adapting to changing habitat conditions (i.e. persistence in urban environments). However, the clearing of native vegetation is likely to have a greater impact on the little bent-wing bat as this species forages below the canopy and is capable of roosting in tree hollows.

The large-eared pied bat was not recorded during field surveys nor has it been recorded in prior surveys (GHD, 2010a). However potential foraging habitat occurs in the vicinity of the Cooperabung Range and individuals may roost under bridges and culverts in the study area. Impacts on potential foraging habitat will be small and will not adversely affect movement or forage resources.

No suitable breeding habitat for any of these species occurs within the study area and none is expected to be impacted as a result of the Proposal. However as the eastern bent-wing bat and little bent-wing bat may utilise bridges and culverts within the study area, with the latter species potentially utilising hollow bearing trees for roosting on a seasonal or occasional basis, there is the potential for individuals of both species to be killed if a bridge, culvert or hollow bearing tree containing roosting bats is destroyed or removed. In addition, increased traffic volumes and vehicle speeds along the service roads, particularly at Rodeo Drive, could result in an increase in the number of road deaths. Impacts on the large-eared pied bat are anticipated to be isolated to a small loss of potential foraging habitat, this being minor and unlikely to be significant for this species.

Grey-headed flying-fox (*Pteropus poliocephalus*) – vulnerable under the NSW TSC Act and Commonwealth EPBC Act

The grey-headed flying-fox is endemic to Australia and presently occurs along the east coast from Bundaberg in Queensland to Melbourne, Victoria (NPWS 2000). This species utilises subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and mangroves, as well as urban gardens and fruit crops for foraging (Churchill 1998; NPWS 2000). The grey-headed flying-fox has been recorded to forage on more than 80 plant species of which eucalypt blossom is considered the major food source, with figs the most common fruit consumed (Churchill 1998). These bats will disperse and commute up to 50 kilometres daily to foraging areas from their day roost (Strahan 1995).

The grey-headed flying-fox roosts in large colonies of up to tens of thousands and often share camps with the little red flying-fox and black flying-fox (Churchill 1998; NPWS 2000). Colonies are usually formed in gullies with a dense vegetation canopy and a water source nearby. Camps have also been formed in modified vegetation in urban areas (NPWS 2002). Site fidelity is high, with some camps in NSW used for over a century. Bats usually return annually in October/November to particular camps for rearing young (NPWS 2002).

The grey-headed flying-fox may migrate up to hundreds of kilometres to where a suitable food source is available. The population concentrates in May and June in northern NSW and Queensland where animals exploit winter-flowering trees such as Swamp Mahogany, Forest Red Gum and Paperbark, dispersing south during the summer (NPWS 2002). When migration occurs they do not move as a colony, but as individuals or small groups resulting in the intermixing sub-populations (Churchill 1998).

The grey-headed flying-fox was recorded throughout the entire length of the Proposal (GHD, 2010a; GHD, 2010b). The presence of this species was confirmed during the survey of the study area (Cooperabung Drive). The nearest known flying-fox camp is at Sea Acres, Port Macquarie and another camp is known from Crescent Head, north of Kempsey and it is considered that this species could seasonally forage anywhere along the road route when local eucalypts are flowering.

The Proposal is unlikely to displace the grey-headed flying-fox, though the loss of foraging habitat is expected to contribute to the cumulative loss of foraging habitat for this species. As no known flying-fox camps would be disturbed, it is considered highly unlikely that the Proposal would disrupt the breeding cycle or roosting behaviour of the grey-headed flying-fox. There is a possibility that road fatalities may increase due to increased traffic volumes and vehicle speeds.

Hollow-roosting bats – hoary wattled bat (*Chalinolobus nigrogriseus*), eastern false pipistrelle (*Falsistrellus tasmaniensis*), east-coast freetail-bat (*Mormopterus norfolkensis*), greater broad-nosed bat (*Scoteanax rueppellii*) and yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*) – all vulnerable under the NSW TSC Act

In general, tree-roosting bats are vulnerable to habitat loss and modification, especially the loss of hollow-bearing trees and good quality foraging habitat. These species are also known to roost in the roofs of buildings. Frequent fires or vegetation changes through pollution or weed invasion can impact on the insect prey base on which these species feed. Some predation by feral and domestic cats may occur in some situations. Any activity that reduces prey or roost availability, probably contributes to the cumulative impacts on these species within localities.

Information on the reproduction cycle of these species is limited, with births reported in December for the hoary wattled bat, eastern false pipistrelle and yellow-bellied sheathtail-bat and January for the greater broad-nosed bat. There is little to no information for the east-coast freetail-bat (Churchill 1998). For all of the subject species, maternity colonies of ten or more individuals have been reported to occur within the upper trunk hollows of large dead or live trees.

With the exception of the hoary wattled bat and yellow-bellied sheathtail-bat, all of the above species have been previously recorded within the Proposal area and are discussed in the Working Paper (GHD, 2010a). The probable recording of the hoary wattled bat was collected from forest vegetation in the southern part of the Stumpy Creek investigation area. The east-coast freetail-bat was positively recorded at the southern end of Cooperabung Drive. Possible calls of the eastern false pipistrelle were also recorded at this location. Probable calls of the greater broad-nosed bat were recorded midway along the Cooperabung Drive service road. The yellow-bellied sheathtail-bat was not recorded during survey work however suitable potential habitat does occur within the study area, particularly throughout dry ridgetop forest vegetation as seen at Rodeo Drive and Ravenswood Road.

Potential foraging habitat for all five species occurs throughout the study area. Potential roosting and breeding habitat occurs in forested areas within the study area and other areas where suitable hollow-bearing trees are located (e.g. paddock trees nearby forested areas). The Proposal is unlikely to displace any of these four hollow-roosting bat species from the study area however some disturbance is expected to occur and the extent of habitat available to these species would be reduced.

The main potential impact associated with the Proposal is expected to be the potential loss of roosting and breeding hollows. A large number of hollow-bearing trees would be lost from within the study area as a result of the Proposal (i.e. Stumpy Creek), including trees containing potential roosting and breeding hollows for these threatened bat species. While it is unknown whether any of these species roosts or breeds within the study area, the removal of a roost tree during the day may result in the death of a number of bats. If a tree containing a maternity roost is removed this could greatly impact the local population of the species, particularly if the roost tree is removed during the breeding season.

The Proposal may also result in an increase in the number of bat deaths by vehicle strike due to increased traffic volumes and vehicle speeds along the new highway. An under bridge fauna crossing at Stumpy Creek would have a positive impact on this potential impact by reducing the potential incidence of vehicle strike.

Potential threatened species habitat recorded during the study area survey

Barred cuckoo-shrike (*Coracina lineata*) – vulnerable under the NSW TSC Act

The barred cuckoo-shrike is distributed along the eastern Australian coast from Cape York Peninsula in the north to the Manning River District, NSW in the south. This species is rare in NSW and is generally found further north. In NSW, the species is most commonly recorded from the Northern Rivers and mid-north coast south to Wollomba River and west to the Richmond Range and Bellingen.

The barred cuckoo-shrike forages for fruit and seeds within the upper canopy of subtropical rainforest, wet sclerophyll forest, swamp woodlands, timbered watercourses and isolated fruiting trees. The barred cuckoo-shrike breeds from October through to January constructing nests in the form of small flat structures of fine twigs, bark, and sometimes casuarina needles, often bound with spiders web and placed high in the upper branches of tree, usually in a horizontal fork (Frith 1979).

This species was not recorded during field survey work nor has it been recorded during prior surveys of the Proposal (GHD, 2010a; GHD, 2010b), However, the study area is located within the species range of occurrence and with the presence of potential habitat the species may occasionally visit the study area. The Proposal is expected to result in the removal of potential foraging habitat for the barred cuckoo-shrike, which would reduce the amount of foraging habitat available to the barred cuckoo-shrike within the locality. However the Proposal is not expected to displace a local population of this species.

The Proposal is also considered unlikely to disrupt the breeding cycle of the barred cuckoo-shrike. There is a low likelihood for a nest site occurring within the path of the area to be cleared. However, if such circumstances are discovered during pre-clearing surveys, then the Proposal could result in a disruption to that season's breeding cycle for the pair involved. Actions to minimise these impacts would be investigated and acted on where appropriate.

As it is likely that the barred cuckoo-shrike would only be an opportunistic visitor to the study area, the extent of habitat to be removed is unlikely to be important to the survival of this species within the locality. The Proposal is therefore considered unlikely to affect the lifecycle of the barred cuckoo-shrike.

Brush-tailed Phascogale (*Phacsogale tapoatafa*) – vulnerable under the NSW TSC Act

The brush-tailed phascogale is a nocturnal, arboreal, carnivorous dasyurid and preys on invertebrates and small vertebrates. The eastern distribution of the brush-tailed phascogale is along the coast and adjacent ranges from southern Queensland to south-eastern South Australia. This species appears to prefer dry open forest types with sparse ground cover though it has also been recorded in moist forest and cool temperate rainforest (Soderquist 1995).

Considered to be the most arboreal of the dasyurids, individuals have been reported using up to 20 nests in a single year, which include hollow tree limbs, rotted stumps and globular bird nests, although breeding nests are usually situated in tree hollows. Recent studies have reported a home range of 37.05 hectares for females and 86.53 hectares for males outside the breeding season (Traill & Coates 1993; Soderquist 1995). Female home ranges do not overlap with other unrelated females however male home ranges can overlap with those of other males and females. The brush-tailed phascogale has a very restricted breeding season, which occurs in the winter with annual male die-off occurring after mating. Births tend to occur during July and August, with the female having up to eight young. Females can live beyond their second year though tend not to breed after this time.

Given the large home range, small population sizes and the reproductive strategy of male die-off, this species is considered to be particularly vulnerable to fragmentation of suitable habitats and local extinctions. The brush-tailed phascogale is vulnerable to road mortality, particularly males during the breeding season or during juvenile dispersal in late spring or early summer.

The brush-tailed phascogale was not recorded within the study area during field survey work though a number of records occur within 2 kilometres. Given the difficulties in surveying for this species, it is considered likely to occur in larger tracts of bushland including those that adjoin or are contiguous with the study area.

The widening of the service road corridors at Cooperabung Drive, Rodeo Drive and Ravenswood Road is not likely to increase the risk of road death for this species. It is the potential increased use and travel speed along the service roads, particularly at Rodeo Drive, that increases the potential for vehicle strike. The greater risk of vehicle strike is therefore a function of increased traffic counts and travel speed not displacement of habitat values if it is present in these parts of the study area.

The clearing of native vegetation at Stumpy Creek has the potential of displacing habitat for this species. In this respect there is a possibility that the Proposal may disrupt the breeding cycle of the brush-tailed phascogale should vegetation clearing involving a hollow tree or log containing a pregnant female or female with young is removed.

Of particular importance to this species is the maintenance and rehabilitation of fauna movement corridors. Measures designed to minimise these impacts include the installation of aerial rope crossings and underpasses designed to maintain habitat connectivity for the brush-tailed phascogale. Supplementary plantings, rehabilitation of currently cleared or degraded habitat and provision of habitat offset may also assist in mitigating long-term impacts on the brush-tailed phascogale.

In summary, potential impacts associated with the Proposal include the loss of potential roosting and breeding hollows, the loss of potential foraging habitat and the further fragmentation of habitat. Service road related fragmentation is likely to lead to an increased risk of vehicle strike (i.e. increased vehicle speed and frequency). As a result of these disturbances, it is considered that the Proposal could potentially affect the life-cycle of the brush-tailed phascogale if it is present in the study area.

Common planigale (*Planigale maculata*) – vulnerable under the NSW TSC Act

The common planigale inhabits rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is sufficient surface cover. This species tends to prefer areas close to water and requires moderate to dense ground cover (particularly areas containing hollow logs) for foraging and breeding. The common planigale is nocturnal and shelters during the day in nests built in crevices, hollow logs, beneath bark or under rocks. At night it preys on insects and small vertebrates. Breeding occurs between October and January with the female building a nest lined with grass, eucalypt leaves or shredded bark (DECCW threatened species profile).

The common planigale was not recorded within the study area during this survey or prior surveys (GHD, 2010a; GHD, 2010b). Only one record exists within 2 kilometres of the study area. However, given the difficulties of surveying for this species, it has potential to occur in forested areas within the study area, particularly those areas near watercourses, drainage lines and swampy areas Such as Stumpy Creek. The main potential impacts associated with the Proposal are expected to be the further fragmentation of habitat and possible disturbance to potential habitat surrounding waterbodies within the study area.

The Proposal is likely to result in the loss of potential areas of habitat for the common planigale within the study area that are in addition to those quantified in GHD (2010b). The Proposal may also disrupt the breeding cycle of the common planigale as it could result in the removal of nest sites under vegetation, bark and logs. While it is unknown what impact this would have on the overall population, the removal of potential breeding habitat associated with the Proposal could result in the loss of individuals, including breeding females that may currently reside within the road corridor.

In addition, the Proposal may increase the risk of road death for common planigales. While the existing highway would already pose a barrier to the dispersal ability of the common planigale, the widening of the road corridor is likely to make dispersal across the highway more difficult. Crossings at each of the sites contained within the study area would substantially minimise the impact of the Proposal.

Eastern chestnut mouse (*Pseudomys gracilicaudatus*) – vulnerable under the NSW TSC Act

The eastern chestnut mouse is an inhabitant of heathland and occurs most commonly in dense wet heath and swampy areas, although has been recorded from open woodland with a grassy understorey (Fox 1983). The species is usually reported in low densities, but populations have been reported to increase up to sixfold in the first 18 months after an intense wildfire, reaching peak densities of six per hectare. These factors would indicate that the optimal habitat for this species is provided by regenerating vegetation.

The eastern chestnut mouse is observed to exhibit a relatively small home range of approximately 0.5 hectares in which prescribed pathway systems are used and maintained among the dense sedge cover present in wet heathlands. The species is nocturnal and forages on a diet of plant material in addition to seeds. The breeding season usually extends from September through to March in which up to three litters of 1-5 young may be produced in one season.

The eastern chestnut mouse was not recorded during the field survey. At best only marginal habitat values exist within the study area at Stumpy Creek. As the Proposal would result in the loss of marginal potential habitat from within the study area there is the potential for an impact on the eastern chestnut mouse. The removal of this vegetation and widening of the road corridor is likely to further fragment habitat for the eastern chestnut mouse if it occurs, making movement between patches of habitat more difficult and increasing the risk of road death. In addition, there is a small chance that vegetation clearing associated with the Proposal may disrupt the breeding cycle of the eastern chestnut mouse, as it may result in direct deaths or loss of habitat for a family group if present.

Forest owls – powerful owl (*Ninox strenua*), barking owl (*Ninox connivens*), masked owl (*Tyto novaehollandiae*) and sooty owl (*Tyto tenebricosa*) – all vulnerable under the NSW TSC Act

All the large forest owl species are known to occupy large territories, particularly in fragmented areas, which is a reflection of their high mobility and the diversity of prey species they take. The barking owl is thought to have the smallest home range of between 30 to 200 hectares while home ranges of up to 1000 hectares have been recorded for the masked owl (Kavanagh and Murray 1996). While these four owl species have different habitat requirements, all are reliant upon mature trees containing large hollows for breeding purposes. These forest owls are generally known to roost in dense foliage or large tree hollows, although the masked owl and sooty owl also roost in caves.

In NSW, the powerful owl has been most commonly recorded within open forests, but woodland, ecotones with cleared areas, riparian habitats and closed forests are also utilised (Debus and Chafer 1994). This species was not recorded within the study area during Ecotone surveys and few records occur within 2 kilometres. However the powerful owl is expected to occur in larger forest remnants within the study area.

The barking owl was not recorded during field survey work, though potential habitat does occur. The barking owl prefers heavily forested areas and is more likely to inhabit larger tracts of bushland, including Cairncross, Ballengarra and Maria River State Forests and Rawdon Creek and Cooperabung Creek Nature Reserves. Movements through the study area are therefore possible.

The masked owl was recorded during the spring field survey in September 2006 as a road kill on the existing highway at Telegraph Point, just south of the Wilson River. Another recent record of this species to the Stump Creek site has been reported in an unrelated survey adjacent to this site (GHD, 2010c). As this species often forages along the forest edge and into cleared habitats, it could occur anywhere along the road route. This species is considered to be particularly vulnerable to vehicle strikes as it primarily takes prey on the ground (Debus and Chafer 1994).

The sooty owl was recorded where the Pacific Highway crosses the Maria River during Ecotone fieldwork in April 2006 for the proposed northbound bridge replacement. A single bird was observed on both sides of the road after it responded to the call playback (Ecotone 2006a). Although not recorded during the survey periods for the road upgrade, potential habitat for this species elsewhere within the study area occurs along the major creeks where rainforest occurs as riparian habitat, with the most likely areas being Barrys Creek and gullies within the Cooperabung Range. A DECCW Wildlife Atlas record for the sooty owl occurs from the Cooperabung Nature Reserve, just to the west of the existing highway.

There is the expectation that potential foraging habitat would be removed as a result of the Proposal. However, given the large home ranges of all of these species and the way they use these habitats, this is unlikely to displace a population of any of these four threatened owl species. Notwithstanding, construction related impacts such as increased light shed and machinery noise at night may cause owls to avoid construction areas and forage further away.

The Proposal is expected to result in the loss of trees containing potential breeding hollows for these four threatened forest owl species. While no nest hollows were recorded during field survey work, the removal of hollow-bearing trees could potentially disrupt the breeding cycle of one or more of these threatened owl species, particularly if a tree containing a nest hollow is removed during the breeding season.

In addition, increased traffic and vehicle speed along the service roads as a result of the Proposal may result in an increased risk of mortality due to vehicle strike for these species. Given the relatively large home ranges of all four species, the loss of one or two individuals could potentially have a significant impact on the local population.

A recovery plan for the powerful owl, sooty owl and masked owl (DEC 2006b) and a draft recovery plan for the barking owl (NPWS 2003b) have been prepared. The Proposal is considered inconsistent with these plans as it is expected to result in the loss of potential foraging and breeding habitat for these species. Mitigation involving the managed removal of potential net habitat and installation of compensatory nest hollows in adjoining habitat would substantially reduce the severity of any adverse impacts experienced by this species as a consequence of the Proposal.

Fruit-doves – rose-crowned fruit-dove (*Ptilinopus regina*), superb fruit-dove (*Ptilinopus superbus*) and wompoo fruit-dove (*Ptilinopus magnificus*) – all vulnerable under the NSW TSC Act

All three species are rainforest species and forage on a variety of fruit bearing trees, shrubs and vines. While their distribution includes coastal NSW, all three species are more commonly found in northern Australia. None of these species have been positively identified within the study locality during prior surveys however the rose-crowned fruit-dove was tentatively identified by GHD in November 2007. All three species have some potential to opportunistically visit areas within the study area that exhibit rainforest elements such as floodplain forests and riparian corridors.

In addition to the losses stated for the entire road section (GHD, 2010a) an additional 1.2 hectares of moist floodplain (Community 7) is expected to be removed as a result of the Proposal. These impacts are considered isolated and of limited consequence especially given that all three species are likely to be only opportunistic visitors to the study area. It is considered highly unlikely that the lifecycle of any of these three fruit-dove species will be greatly affected by the Proposal.

Giant barred frog (*Mixophyes iteratus*) and stuttering frog (*Mixophyes balbus*) – both endangered under the NSW TSC Act, with the giant barred frog also listed as endangered and the stuttering frog as vulnerable under the Commonwealth EPBC Act.

Both the giant barred frog and stuttering frog have a preference for riparian habitats and are usually associated with wet sclerophyll forest or rainforest, but only where clean, flowing streams occur (Robinson 1993; White 1994). In NSW the giant barred frog is usually found at low altitudes and the stuttering frog at mid to low altitudes. Both species avoid sites void of vegetation and still water-bodies (Robinson 1993). They are affected by the loss or modification of riparian vegetation and are likely to be susceptible to declining water quality, including sedimentation and increasing turbidity. The giant barred frog and stuttering frog require specific conditions for breeding and forage in riparian and adjacent forest habitats (White 1994; AMBS 1995).

The giant barred frog has been recorded at Maria River in prior surveys for this Proposal, with repeat surveys validating their presence (GHD, 2010a). Potential habitat for the giant barred frog occurs at Stumpy Creek, however their presence was not detected during the recent field survey conducted within the study area. Low potential habitat values for the stuttering barred frog has been identified at Stumpy Creek, with the site more suited to the giant barred frog.

The Proposal is unlikely to displace the giant barred frog or the stuttering frog however there is the potential for individuals of these species to be killed during construction works at bridge sites. Any pollution or sedimentation of waterways resulting from the Proposal could potentially impact the lifecycle of these species. In addition, there could potentially be a greater risk of road death due to increased traffic volumes and vehicle speeds along the new highway, though both species are more likely to follow the riparian strip under an existing road bridge.

Mitigation measures designed to protect water quality and riparian vegetation cover (including leaf litter) are required to limit impacts on potential habitat locations within Stumpy Creek. Further the facilitation of fauna movement along the Stumpy Creek riparian corridor via an underpass beneath the bridge is desirous. The current conditions should be upgraded with fauna friendly design to facilitate these east west movements (i.e. continuous vegetated bank along either side of the waterway).

As the Proposal involves the loss of potential habitat at Stumpy Creek, mitigation and management measures are required to minimize the impact. Improved site management practices such as those developed at the Maria River represent the minimum requirements for the management of impacts at Stumpy Creek. These would need to be developed at the detailed design stage in consultation with the relevant authorities. Within this context the life cycle of the giant barred frog population is unlikely to be adversely affected by the Proposal.

Giant dragonfly (*Petalura gigantea*) – endangered under the NSW TSC Act

The giant dragonfly has been recorded from both coastal and upland permanent wetlands from Moss Vale to southern Queensland, but has not been recorded in most areas for many years. The larval stage for this species is at least 10 to 30 years, with adults emerging in October-November and flying until January. The greatest known threats to this species are declining population size and loss or degradation of wetland habitats (DECCW threatened species profile)

The giant dragonfly was not specifically targeted during field survey work though suitable potential habitat occurs in permanent swamps and bogs within the study area, particularly on the Hastings River and Wilson River floodplains. Only one record of this species exists for the locality, though this may be more a reflection of the fact that the giant dragonfly spends most of its life in larval form and is thus unlikely to be reported. Potential impacts associated with the Proposal that may affect the lifecycle of this species include the loss of wetland habitat within the study area and potential changes to water quality that may result from pollution and sediment runoff. As this species has a very long larval stage, if a population of the giant dragonfly occurs, these impacts could potentially adversely affect the lifecycle of this species through direct deaths and disruption of the breeding cycle.

Glossy black cockatoo (*Calyptorhyncus lathami*) – vulnerable under the NSW TSC Act

The glossy black cockatoo occupies forests of south-eastern Australia, from Shoalwater Bay in central Queensland to the Victorian border region. Preferred habitat for this species generally consists of moist and dry eucalypt forest types with a she-oak understorey. In areas where she-oaks are abundant, this species is sedentary, however, in other areas glossy black cockatoos can be nomadic, moving from one food source to another (DECCW threatened species profile).

The breeding season is between March and August with eggs usually being laid between April and June. The nests are located in large hollow limbs or trunks, often in tall dead trees standing in clearings. The nests are usually between 13 and 22 metres above the ground. The glossy black-cockatoo relies almost entirely on the seeds of a few species of she-oak for food and any factor that reduces the quantity, quality or availability of the seed crop of these trees must have a direct impact on local populations, through starvation or reduced fecundity (DECCW threatened species profile).

The glossy black-cockatoo was not recorded within the study area during the survey period however it is known to occur along the length road affected by the Proposal (GHD 2010a; GHD, 2010b). The main potential impacts associated with the Proposal include the loss of potential nest trees (those containing large hollows) and the loss of potential foraging habitat.

The Proposal is expected to result in the loss of potential foraging habitat for the glossy black-cockatoo at Stumpy Creek. While this is not expected to greatly affect the lifecycle of the glossy black-cockatoo in the short term, it would contribute to the cumulative loss of habitat affecting this species. The Proposal is also expected to result in the loss of a large number of hollow-bearing trees, including those containing potentially suitable nest hollows for the glossy black-cockatoo. While no nest trees were recorded within the study area during field survey work, the loss of a nest hollow could potentially disrupt the breeding cycle of the glossy black-cockatoo, particularly if it is removed during the breeding season.

Mitigation involving the managed removal of potential nest habitat and installation of compensatory nest hollows in adjoining habitat would substantially reduce the severity of any adverse impacts experienced by this species as a consequence of the Proposal.

Golden-tipped bat (*Kerivoula papuensis*) – vulnerable under the NSW TSC Act

The golden-tipped bat has been recorded in a narrow band in coastal areas and the sub-coastal slopes and ranges from Cape York Peninsula in Queensland south to the New South Wales/ Victorian border. Moist closed lowland forest appears to provide the most favoured habitat type for this species (Woodside 1995). The majority of captures of the golden-tipped bat have been made in coastal forests, near to where wet and dry forest ecotones occur, and often in the vicinity or over creeks. The species is known to occur in areas where dense or tangled vegetation is present, and along creeks, suggesting that the flight habits are suited to foraging in dense vegetation and in ecotonal habitats.

It is expected that this species feeds by gleaning, flying slowly in dense vegetation, and hovering to collect insects and spiders from vegetation or out of webs while on the wing (Schulz 2000). Golden-tipped bats have been located roosting in abandoned gerygone and scrubwren nests. These are dome-shaped nests made of bark fibre, moss and lichen and hang from vines and twigs (Churchill 1998). Little is known of the reproductive biology of this species in Australia, though it is considered likely that in southern Australia the golden-tipped bat breeds in early spring (Woodside 1995).

The golden-tipped bat was not recorded during field survey work however suitable potential habitat does occur in areas of rainforest and adjacent sclerophyll forest within the study area. This is particularly relevant to habitats identified at Stumpy Creek. The Proposal is likely to result in the loss of potential foraging, roosting and breeding habitat for the golden-tipped bat however; much of this potential habitat is degraded and not considered ideal for the golden-tipped bat. The loss of these areas would contribute to the cumulative loss of habitat affecting this species. In the event that a population of the golden-tipped bat does occur in any of the areas to be cleared, the loss of that habitat could displace or result in the loss of that population, particularly if a breeding colony is destroyed.

Grass owl (*Tyto capensis*) – vulnerable under the NSW TSC Act

The grass owl occurs in all mainland states of Australia and in NSW is more common in the north-east. This ground-dwelling owl species inhabits areas of tall grass on grassy plains, swampy areas and floodplains. It rests by day and also nests on a trampled platform hidden in dense tall grass or sedges (DECCW threatened species profile).

The grass owl was not recorded during field survey work however marginal potential suitable habitat does occur in areas of grassland on the Hastings River and Wilson River floodplains. As the proposed route travels through this area, potential habitat for the grass owl would be lost as a result of the Proposal. While this is unlikely to displace a local population of the grass owl, it would contribute to the incremental loss of habitat affecting this species. In the unlikely event that a nest containing eggs or chicks were to be destroyed during clearing or construction activities, this would disrupt the breeding cycle and could potentially adversely affect the local population.

Green and golden bell frog (*Litoria aurea*) – endangered under the NSW TSC Act and vulnerable under the Commonwealth EPBC Act.

The green and golden bell frog was once a common species in coastal New South Wales, where it inhabited vegetated dams and reed beds in rivers, swamps and lakes. The range of this species extended almost continuously from the far north coast of New South Wales to the east Gippsland district of eastern Victoria, and inland to 800 metres on the southern tablelands. By the early 1980's, this species had undergone a dramatic population decline, becoming scarce and possibly extinct in the tablelands and Australian Capital Territory, and populations in coastal areas were reduced and isolated. Habitat destruction, predation by the introduced mosquito fish (*Gambusia holbrooki*) and possibly a fungal infection (Chytridiomycosis) have been implicated in the rapid decline of this species (Pyke & Osborne 1996).

The green and golden bell frog is semi-aquatic, and does not undertake regular seasonal migrations away from the edges of waterbodies, although terrestrial movements have been reported, presumably in search of new breeding sites. This species utilises a range of habitats including slow-moving or still, permanent and semi-permanent ponds, lakes, creeks, swamps and farm dams. Most breeding records have been located within still, vegetated (especially by *Typha* sp) ephemeral ponds, which are unshaded and free of predatory fish (especially mosquito fish). Males call while floating in water, from August through to January, although they have been heard at other times. The green and golden bell frog is active during both the day and night.

The green and golden bell frog was not recorded during recent surveys of the study area or during prior surveys and given the lack of nearby records and the pattern of decline for this species, it is considered unlikely to occur. However there is a presence of potential habitat at the southern end of the study area, this potentially subject to adverse impacts from the proposal (i.e. habitat removal or modification from indirect impacts). Pre-construction fauna surveys should be undertaken to confirm the absence of this species from the study area. If a population does occur within the study area, then steps should be taken to isolate the impacts and mitigate where possible.

A draft recovery plan for the green and golden bell frog has been prepared (DEC 2005). While the Proposal is likely to result in the loss of some potential habitat for this species, as no known population occurs, the Proposal is not considered inconsistent with the draft recovery plan for this species.

Green-thighed frog (*Litoria brevipalmata*) – vulnerable under the TSC Act.

The green-thighed frog is known from isolated localities in rainforest and wet sclerophyll forest along the northern coast of New South Wales and south-eastern Queensland (Cogger 1995). Breeding aggregations of the species occur around grassy semi-permanent ponds in late spring and summer.

The green-thighed frog was recorded in Rawdon Creek Nature Reserve and Maria River State Forest (GHD, 2010a; GHD, 2010b). Geomorphological similarities exist between Stumpy Creek and Maria River and on this basis it is considered that the green-thighed frog is likely to also occur at Stumpy Creek.

The proposed alignment intersects potential breeding habitat within the Stumpy Creek site and as such the Proposal could therefore result in the disturbance of a breeding pool for the green-thighed frog and potentially disrupt the breeding cycle for this species. As the size of the local population is unknown, the possible impacts are difficult to quantify. However if this is an important population any disturbance could potentially significantly affect the local population of the green-thighed frog.

The widening of the road corridor, increased traffic volumes and vehicle speeds may result in an increased number of road deaths as individuals travel to and from breeding and foraging areas. This would be a particular problem during wet weather. Underpasses would reduce the risk of road death for this species.

The following strategy would be adopted to reduce the potential for an adverse impact at Stumpy Creek:

- Undertake pre-construction surveys to determine if the species is present within the path of the Proposal.
- In areas where known habitat for the green-thighed frog would be disturbed, measures to mitigate impacts would be discussed and negotiated with DECCW. The results of any recent research regarding the breeding requirements of this species or the effectiveness of mitigative strategies implemented on other sections of the Pacific Highway upgrade would be used to inform the design of mitigation measures for the Proposal.
- Potential mitigative measures could include the creation of artificial habitat associated with the existing creek line during construction. The constructed habitat would be designed to mimic the natural situation where breeding occurs within areas of impeded drainage close to sites of intact native vegetation. The pond designs would include the following features as specified for those created for the Kempsey to Eungai section of the Pacific Highway Upgrade (PB 2008):
- Size: 20 metres diameter (core pond), but could be a series of potholes/ponds and larger flooded areas.
- Depth: variable depth to 1 metre.
- Shape: steep sides reducing evaporation and increasing water volumes.
- Length of time for inundation: of the order of 40 days for sunny site, 100 days for shaded site.
- Location: next to moist forest areas if possible.
- Vegetation: dense understorey vegetation or leaf litter.
- An ecologist with specialist knowledge of the green-thighed frog would be engaged to undertake an adaptive monitoring program to determine the effectiveness of mitigation measures and to recommend modifications where necessary.
- The development of specific mitigation and management measures would be undertaken at the detailed design stage to address the habitat of the local Green-thighed Frog population. The mitigation and management measures would be specifically targeted towards minimising any impacts on this population and would be undertaken in consultation with DECCW.

Grey-crowned babbler (*Pomatostomus temporalis temporalis*) – vulnerable under the NSW TSC Act

In NSW the grey-crowned babbler occurs on the western slopes and plains and is less common at the higher altitudes of the tablelands. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (NPWS 2001). The grey-crowned babbler inhabits open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer. This species may also be observed along streams in cleared areas and grassy road verges (Morcombe 2000; NPWS 2001; Readers Digest 1979).

Foraging on insects and spiders, the grey-crowned babbler spends the majority of its time searching through leaf litter and soil for food, but will also venture into vegetation (Morcombe 2000; Readers Digest 1979). These sedentary birds live in groups of 5 to 12 and defend a territory of approximately 12 hectares (Readers Digest 1979). Although the entire group assists in building a nest and feeding young, there is usually only one breeding pair in each group and they mate for life (Readers Digest 1979). Breeding occurs between July and February (Morcombe 2000). Their large domed nests (up to 50 centimetres wide) are constructed in trees at a height of about 4 metres to 7 metres. They tend to be built into an upward sloping or horizontal, multiple forked branch in the trees upper outer foliage and have a side entrance tunnel (Morcombe 2000). Nest like structures are also used for the babbler families to roost in overnight.

The grey-crowned babbler species was not recorded during the field survey and no records exist for the locality. However potential habitat has been identified in the dry woodland and open forests of the study area. Given the lack of records, the Proposal is considered unlikely to affect the lifecycle of the grey-crowned babbler however it is expected to result in the loss of some potential habitat for this species.

Koala (*Phascolarctos cinereus*) – vulnerable under the NSW TSC Act.

Distributed from about Townsville, Queensland to the Victorian / South Australian border, from the coast to the western slopes and plains in New South Wales, this species is rare in the north and south of its range and nowhere can it be considered abundant. The koala is a foliovore, feeding on preferred eucalypt species and is found in a variety of habitats where suitable food trees occur (DECCW threatened species profile).

Koalas are generally solitary except during the mating season and have a home range of about 3 hectares, though long movements in search of a mate or new food source are possible (Phillips 1990). The breeding season begins about September, when males commence calling and searching for reproductive females, and ends about April.

No koalas were sighted during the recent surveys of the study area, though anecdotal reports of koala activity in the Ravenswood Road, Rodeo Drive and Cooperabung Drive service roads was noted during conversations with residents. These anecdotal reports are consistent with habitat analysis of these parts of the study area where considerable preferred tree forage species are present (i.e. tallowwood, small-fruited grey gum and forest red gum). Further details of koala usage and sightings are discussed in the Working Paper (GHD, 2010a).

Widening of the highway as a result of the Proposal is restricted to the Stumpy Creek location where an increased risk of road death for the koala may occur as there will be an increase in travel distance across road traffic. Ameliorative measures such as floppy top fencing and an underpass at this location would assist in minimising future road fatalities.

However, this type of impact is not expected along the service roads. A loss of preferred forage trees within the road reserve may possibly occur along with increased traffic frequency and vehicle speed, with the latter potentially increasing the risk of vehicle strike. This could potentially result in some koalas being displaced from their current territories and may also impact the dispersal ability of the koala. Ameliorative measures such as the avoidance of mature trees within the road reserve and supplementary plantings using preferred tree forage species would minimise these impacts. The investigation of reduced speed advisory signs combined with wildlife warning signs is also recommended, particularly at Rodeo Drive.

A draft recovery plan for the koala has been prepared (NPWS 2003c). The overall objectives of this recovery plan are to reverse the decline of the koala in NSW, to ensure adequate protection, management and restoration of koala habitat and to maintain healthy breeding populations of koalas throughout their current range. Specific objective number two is considered potentially relevant to the Proposal and addresses the issue of rehabilitation and restoration of koala habitat and populations. As the Proposal is expected to result in the loss and further fragmentation of koala habitat, it is considered inconsistent with the objectives of this plan. However, the inclusion of floppy top fencing and fauna underpasses at suitable locations along the Proposal would be an important element of the detailed design to minimise the potential for adverse impacts by facilitating safe fauna movements and potentially reducing the road death toll on koala.

Long-nosed potoroo (*Potorous tridactylus*) – vulnerable under the NSW TSC Act and Commonwealth EPBC Act

The long-nosed potoroo inhabits coastal heath and wet and dry sclerophyll forests in areas with an annual rainfall of greater than 760 millimetres. A critical habitat requirement is a relatively thick ground cover of grass-trees, rushes, sedges, ferns, heath, low shrubs, tea trees or paperbarks and it seems to be concentrated in areas where the soil is light and / or sandy loams (Johnston 1995). The diet of the long-nosed potoroo consists of roots, tubers, fungi, insects and their larvae, and other soft-bodied soil fauna. Foraging is commenced at dusk and individuals rarely venture far from cover (Johnston 1995). The long-nosed potoroo occupies a stable home range of 1.4 hectares for females to 2.0 hectares for males, with a high degree of overlap, as the species is not territorial (Seebeck 1996). Births may occur throughout the year, but frequently there are two distinct breeding seasons annually, at the end of winter / early spring and in late summer.

The long-nosed potoroo was not recorded during field survey work within the study area and no records occur within the study locality. Notwithstanding there is a low potential for this species to occur within habitats at Stumpy Creek.

The Proposal is likely to result in the removal of potential habitat for this species and increase the risk of vehicle strike. If a population does occur, individuals could potentially be killed during clearing operations. In addition, increased traffic volumes and vehicle speeds along the service road could potentially result in an increased risk of road death for the long-nosed potoroo. Mitigation including the upgrading of the bridge overpass to include a fauna friendly movement pathway is recommended together with pre-construction surveys.

Osprey (*Pandion haliaetus*) – vulnerable under the TSC Act and migratory under the EPBC Act

The osprey is distributed in coastal areas and inshore waters of New South Wales, Queensland, Northern Territory, Western Australia, and South Australia. Commonly inhabiting mangroves, coastal rivers, estuaries, inshore seas and coastal islands, the osprey commonly feeds on fish, which are taken by a feet-first plunge. Other dietary components include dead fish, seas snakes, birds, crustaceans, mammals and amphibians (DECCW threatened species profile)

Breeding usually occurs between April and September, in a bulky nest constructed of sticks and sometimes roughly lined with seaweed, in a tall mostly dead but sometimes living trees, with power poles or transmission towers also used (Clancy 1991). Nests are usually located in exposed positions, with easy access and good visibility, generally within 2 kilometres of suitable feeding areas.

The osprey has been recorded in previous studies of the Proposal (GHD, 2010a; GHD, 2010b). During this survey no nest sites were observed or are known to occur within the study area. However, two nest sites are known to occur to the east of the study area at Blackmans Point near the Hastings River and at Hatch Road on the edge of Maria River (GHD, 2010a.). In addition to the Hastings River area, the osprey is also likely to occur on the Wilson River and Maria River floodplains.

As no nest sites or foraging habitat for the osprey are likely to be affected, the Proposal is considered unlikely to affect the lifecycle of this species, although occasional vehicle strikes could occur. Foraging habitat is restricted to the major waterways of the area, these not being impacted by the proposal.

Pale-headed snake (*Hoplocephalus bitorquatus*) – vulnerable under the NSW TSC Act

The national distribution of the pale-headed snake includes the coast, ranges and western slopes of eastern Australia, from Wyong, Tuggerah and the Hunter Valley in the south, to Cape York in far north Queensland (NPWS 2002). The preferred habitat of the pale-headed snake is regarded as dry hardwood forests and woodlands, especially in the vicinity of watercourses. Moist hardwood forests and rainforests are also known to be utilised by the pale-headed snake (AMBS 1995). The species appears to require vegetation with old-growth features, and is not known to occur in either largely disturbed environments or recently regenerating vegetation. The pale-headed snake is a nocturnal, partly arboreal snake and utilises tree hollows and loose bark for sheltering and foraging. Examination of museum specimens identified frogs and geckoes as the main prey items of this species along with small mammals (AMBS 1995), including bats and mice.

The pale-headed snake was not recorded during prior or recent surveys for this Proposal. However, potential habitat for this cryptic species occurs in forested areas within the study area particularly the drier habitats where there are ironbarks occurring. The Proposal is expected to result in the loss of potential foraging habitat and shelter sites for the pale-headed snake as well as further fragment habitat for this species.

The paucity of local records would suggest the likelihood of an impact on this species is low. However, should an impact occur it is possible that the magnitude of this impact would be substantial. Given the cryptic nature of this species it is considered that a local population is only likely to be identified during vegetation clearance works, this often resulting in the death of individuals (i.e. individuals in hollow bearing tree). In addition, increased traffic volumes and vehicle speeds along the services roads could potentially result in an increased risk of road death for the pale-headed snake. Pre-clearance surveys and tree hollow management during construction is recommended together with the use of fauna underpasses along the length of the Proposal.

Regent honeyeater (*Anthochaera phrygia*) – critically endangered under the NSW TSC Act and endangered under the Commonwealth EPBC Act and swift parrot (*Lathamus discolor*) –endangered under the NSW TSC Act and Commonwealth EPBC Act; the swift parrot is also listed as migratory under the Commonwealth EPBC Act.

The regent honeyeater is known to breed on the western slopes of the Great Dividing Range and the swift parrot breeds in Tasmania. Both are seasonal or opportunistic visitors to coastal NSW and forage in areas containing winter-flowering trees (eg. the swamp mahogany and spotted gum). Neither of these species was recorded during the field survey, though both have potential to occur, particularly during peak winter flowering periods.

The Proposal is considered unlikely to significantly affect the lifecycle of either the regent honeyeater or swift parrot. However it is expected that there will be a loss of potential foraging habitat, including important winter-flowering trees, which would contribute to the cumulative loss of habitat affecting these species. The clearing of potential regent honeyeater and swift parrot habitat is inconsistent with the aims of the recovery plans for these species (Swift Parrot Recovery Team 2001; Regent Honeyeater Recovery Team 1999), though given the paucity of records for both species, the habitat to be cleared is considered unlikely to be critically important to the survival of either species.

Mitigation would include the consideration of seasonal clearing events (outside the winter period) use of roadside revegetation and use of offsets.

Southern myotis (*Myotis macropus*) – vulnerable under the NSW TSC Act

The southern myotis is apparently widespread but uncommon in northern New South Wales (AMBS 1995) and considered comparatively rare over its limited national range (Richards 1983). A variety of foraging habitats are used by this species although it is usually found near large bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to the roost site. The southern myotis forages predominantly just above the water surface of open water bodies but also rakes the surface of the water with the recurved claws of its large feet and sometimes uses its tail membrane as a scoop (Menkhorst 1995).

The species appears to have specific roost requirements and only a small percentage of available caves, bridges, mines, tunnels and culverts are used. Colonies usually number between 10 and 15 individuals, but colonies of up to several hundred individuals have been reported in a single roost (Richards 1983). In New South Wales breeding occurs between October and February with two distinct birthing times occurring in October and early February when a single young is produced.

Loss of roost sites and foraging habitats are considered the major threats to this species. The specific nature of its foraging habits suggest that this species is adversely impacted by habitat degradation through water pollution, and foraging habitat is likely to have been lost through nutrient enrichment, oil spills and pollutant rich run-off entering waterways. Disturbance of colonies, especially during the breeding season or in colder months when the bat is in torpor, may cause populations to desert roost sites and can result in heavy mortality (Ayers *et al*. 1996).

The southern myotis has been positively recorded with the impacted area of the Proposal (GHD, 2010a). However, no records of this species were collected during the recent survey of the study area. Notwithstanding the study area has dams and creeklines that represent potential foraging habitat and the southern myotis could potentially roost under bridges and culverts such the Stumpy Creek crossing. Prey species are present within Stumpy Creek including native fish species, making this part of the study area potentially important for this species.

The foraging activity of the southern myotis is unlikely to be significantly compromised as a result of the Proposal. However if the Proposal were to result in the pollution or degradation of creeklines and other waterbodies within the study area, this could affect the availability of prey species.

Increased traffic volumes and vehicle speeds along the service roads adds to the elevated risk posed by the Proposal, this potentially leading to an increased risk of vehicle strike. There is also the potential for the loss of potential roost sites. As the southern myotis is known to roost under bridges and culverts, the removal of these structures could result in the deaths of roosting individuals, particularly if non-flying young are present or during winter months when bats enter torpor. If a bridge containing a maternity roost was destroyed, this could potentially result in the displacement of an entire colony and loss of young. Mitigation involving the avoidance of impacts during the breeding season combined with pre-clearance surveys would substantially reduce the potentia for an adverse impact. On this basis it is considered unlikely that the Proposal would lead to the extinction of the local population of the southern myotis.

Spotted-tailed quoll (*Dasyurus maculatus*) – vulnerable under the NSW TSC Act; endangered under the Commonwealth EPBC Act

The current distribution of the spotted-tailed quoll is along the coast and ranges of eastern Australia from southern Queensland to the Victorian/South Australian border and Tasmania. The mainland range of this species has been much fragmented and significantly reduced and is now disjunct over much of its former range. The spotted-tailed quoll utilises a wide range of habitat types including rainforest, wet and dry sclerophyll forest, woodland, coastal heathland and inland riparian forest (Edgar & Belcher 1995). The species appears to prefer moist sclerophyll and rainforest forest types, as well as riparian habitat and is most common in large continuous patches of forest, favouring dense habitats with a lot of ground litter on the forest floor (DEH 2004).

A solitary, nocturnal and semi-arboreal species, the spotted-tailed quoll preys on a variety of species ranging in size from small wallabies to insects, as well as plants. The spotted-tailed quoll utilises an extensive home range, estimated to be between 500 hectares and 1000 hectares (AMBS 1995).

This species was not recorded within the study area during recent field surveys, though a few records occur nearby these confirmed by anecdotal records from local residents. DECCW's Atlas of NSW Wildlife indicates four main clusters of spotted-tailed quoll records (possibly sub-populations) associated with state forests and nature reserves located to the west side of the existing highway. Nearly all of the records are associated with creeklines within large patches of forest. East of the highway, the species appears to be generally absent with only a few scattered records although there is no certainty that these records are a true indicating of species activity in this area.

Road-related deaths are quite common for the spotted-tailed quoll, as the species often scavenges on road kill. The lack of database records along the existing highway suggests that the species is unlikely to use the highway corridor and adjoining habitats, particularly the drier ridgetop forests, on a regular basis, if it does at all. Furthermore, the current distribution of the species, as indicated by the existing records, suggests that core habitat for the species is not likely to be within habitats close to the highway and that the species is unlikely to move between habitats on each side of the highway on a regular basis.

No latrine or den sites have been recorded within study area. Rock shelters and small caves were absent and large logs were generally found to be sparsely scattered throughout the study area. Hence it is unlikely that the study area provides optimal denning habitat. Conversely, the study area provides potential foraging habitat and movement corridors between habitat, this particularly evident in the Stumpy Creek and Ravenswood Road sites.

Vegetation clearance resulting from the Proposal would be of a long, linear nature. The majority of clearing would be adjacent to the existing highway resulting in a further fragmentation of habitat, potential loss of den sites and a potential increase in the risk of road fatality.

At present, there is limited capacity for the species to move between habitats on either side of the existing highway. However, with the installation of fauna crossings particularly near the Stump Creek and Ravenswood Road sites it is considered that there is opportunity at the detailed design stage to ensure that sufficient passage is provided to allow terrestrial fauna, including the spotted-tailed quoll, to transit safely between habitats on either side of the highway. The species has been recorded using underpasses in gullies and drainage lines (AMBS 1997; AMBS 2001), hence are likely to use bridges as underpasses, providing dry passage is available.

Square-tailed kite (*Lophoictinia isura*) – vulnerable under the TSC Act

The square-tailed kite occurs in coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW the species is a regular resident in the north, north-east and along major river systems and a summer breeding migrant to the south-east. The square-tailed kite inhabits a variety of wooded habitats and exhibits a preference for timbered watercourses. This species preys on passerines, insects and reptiles within the tree canopy and often feeds on young birds stolen from the nest (DECCW threatened species profile).

The square-tailed kite has been previously recorded within this Pacific Highway upgrade section (GHD, 2010a). However, no further observations of this species or nesting sites were noted during the survey of the study area. On this basis the Proposal is unlikely to displace the square-tailed kite, though the loss of a foraging habitat along the Proposal is expected to have an impact. While this species forages above or within the tree canopy, there is the potential for occasional vehicle strikes to occur.

The square-tailed kite nests on a large limb or fork of a tree and has been previously recorded nesting in the area. While potentially suitable nest trees are likely to be removed as a result of the Proposal, no evidence of a nest was observed within the study area during the field surveys. Unless a nest tree is subsequently discovered during pre-clearance surveys and not relocated it is considered unlikely that the Proposal would have a substantial adverse impact on the breeding cycle of the square-tailed kite.

Squirrel glider (*Petaurus norfolcensis*) – vulnerable under the NSW TSC Act

The squirrel glider is distributed along the coast and ranges of eastern Australia from about Cairns in north Queensland to the Victorian/ South Australian border, extending to the western slopes and plains. This species usually inhabits dry open sclerophyll forest and woodland but there have been observations in moist regenerating forest and moist gullies. Although requiring nesting/den hollows, this species is not dependent on mature forest as sightings have been made in Eucalyptus plantations and forest remnants (Ray Williams, Ecotone Ecological Consultants, pers. obs.). It is possible that disused common ringtail possum dreys and birds nests are used in the absence of an abundance of suitable hollows. The diet includes acacia gum, eucalyptus sap, nectar, honeydew, manna, invertebrates and pollen (Quin 1995). Survey work indicates a home range of about 13 hectares and a population density of 0.4 to 1 per hectare in a Victorian population (Traill & Coates 1993) and 3.0 to 3.5 hectares with a density of 0.89 to 1.54 per hectare in a mid north coast population (Quin 1995). The breeding season varies between localities and may be tied to the availability of food resources (Williams 1990; Quin 1995).

This species is reliant upon hollow-bearing trees for roosting and breeding purposes and requires a reasonable level of vegetation connectivity in order to move freely from one area to another. Potential impacts associated with the Proposal include the loss of potential roosting and breeding hollows, the loss of potential foraging habitat and the further fragmentation of habitat associated with the proposed widening of the highway. Ameliorative measures such as aerial rope crossings, trees or poles in the median strip may assist in maintaining habitat connectivity for the squirrel glider. Aerial rope crossings have been installed at the Karuah bypass section of the Pacific Highway and although there is some photographic evidence that these have been used by the squirrel glider, common brushtail possum and the koala, the extent of use has not been determined.

If a population of the squirrel glider does occur within the study area, the Proposal has the potential to displace one or more family groups from their current territories in some areas along the road route. This is particularly the case where large areas of vegetation are likely to be cleared, for example where the proposed route results in the removal of potential habitat with hollow bearing trees (i.e. Stumpy Creek). This could potentially result in an overall decline of squirrel glider numbers within the vicinity of the study area.

A large number of hollow-bearing trees are expected to be lost as a result of the Proposal. Stumpy Creek contains a substantial number of hollow bearing trees with their removal having the potential to directly impact this species. While the squirrel glider will utilise a number of roosts within its home range, the loss of a roost tree contributes to the overall loss of roosting and breeding hollows affecting this species. In the absence of targeted mitigation such as pre-clearance surveys and provision of compensatory habitat, the Proposal has the potential to result in the death of individual gliders.

The Proposal is likely to have a cumulative impact by further fragmenting habitats thus continue to isolate sections of potential squirrel glider habitat. This is particularly relevant to Stumpy Creek. The widening of the service road easements would also make it more difficult for the squirrel glider to cross the new highway. Squirrel gliders can cover distances of over 50 metres in one glide depending on the height of the launch tree (DECCW threatened species profile). However glides of less than 50 metres are more common and a road crossing of more than this distance may pose a barrier to movement or deter the squirrel glider from crossing at that point.

Proposed mitigative measures (such as glider poles and aerial rope ladders) will be important for maintaining habitat connectivity for this species at the Stumpy Creek location. The design of crossing points would require the consideration of launch heights and effective glide distances. A tree 20 metres to 25 metres tall can be used by a squirrel glider to glide an approximately 40 metres horizontal distance. Provisions for safe glide distances across the study area to ensure there are no substantial barriers to squirrel glider movement that could potentially affect the dispersal ability of this species.

Stephens' banded snake (*Hoplocephalus stephensii*) – vulnerable under the NSW TSC Act

Stephens' banded snake is an arboreal, nocturnal snake largely restricted to remnant forests in eastern Australia (Fitzgerald et al. 2005) and is usually associated with moist hardwood forest or rainforest (Klippel 1992). The species has also been recorded in rock outcrops, coastal open forest and dry forest types. Key elements of the preferred habitat of this species include a large (greater than 9000ha) area of forest with a large number of hollow bearing trees. In terms of conservation for this species, appropriate management of large areas of forest with abundant hollow trees is necessary, including maintaining the interconnectivity of forest patches. The species mostly forages in arboreal habitats and the tree canopy, where the snakes prey on a range of species including lizards, birds and small mammals including bats (Cogger 1992; DECCW Threatened Species Profile).

Stephens' banded snake was not recorded during field survey work and no nearby records occur, though potential habitat occurs in rainforest and eucalypt forest within the study area (i.e. Stumpy Creek). Potential impacts associated with the Proposal include the fragmentation of habitat, loss of hollow-bearing trees and loss of foraging habitat.

Given that much of the habitat likely to be affected by the Proposal is marginal for Stephens' banded snake, the Proposal is considered unlikely to greatly affect the life cycle of this species. However, if this species does occur, the widening of the road corridor would increase the fragmentation of Stephens' banded snake habitat within the study area and potentially increase the risk of road death. Mitigation such as pre-clearance surveys and provision of snake friendly underpasses would substantially reduce the severity of any adverse impacts on this species.

Wallum froglet (*Crinia tinnula*) – vulnerable under the NSW TSC Act

The wallum froglet is a small, cryptic species known to inhabit acid paperbark swamps in coastal wallum and heath growing on Quaternary sand (Cogger 1992; Ingram & MacDonald 1993). This species does not tend to colonise permanent waterholes and avoids deep water sites. The main vegetation types include reeds, sedges and ferns, and in particular include the gramminoid clay heaths of *Themeda australis*, *Isachne globosa*, and *Hakea* sp. *A* and wet sedgelands of *Blechnum ambiguum*, *Hypolaena* sp. and *Callistemon pachyphyllus*. Breeding is thought to take place in late winter, from about July to September as calling takes place from May through to September, although some calling has been heard at other times of the year (Cogger 1992; Robinson 1993).

The wallum froglet was not recorded during recent field surveys however low value potential habitat occurs in paperbark and sedge swamps within the study area. The main areas where wallum froglet habitat is likely to be removed or disturbed as a result of the Proposal are in Lot 2 DP 621797 located on the Wilson – Maria River floodplain.

The wallum froglet is sensitive to changes in water quality and levels of acidity within habitat areas. Any pollution, sedimentation or nutrient runoff into areas of potential wallum froglet habitat could adversely affect the suitability of that habitat. This could potentially disrupt the breeding cycle of the wallum froglet or displace the species from that area, though it is worth noting that wallum froglets have been recorded from roadside habitats.

The Proposal is likely to result in the small area of low value potential wallum froglet habitat from within the study area. If a population of this species does occur, this would result in the wallum froglet being displaced from those areas to be cleared and reduce the overall habitat availability for the species. Mitigation measures such as the installation of adequate sediment and pollution control measures to minimise the risk of indirect impacts on water quality is an important action in reducing the potential for an adverse impact on this species.

Wetland birds –, Australian painted snipe (*Rostratula benghalensis*), black-necked stork (*Ephippiorhynchus asiaticus*), black bittern (*Ixobrychus flavicollis*) and comb-crested jacana (*Irediparra gallinacea*) – the Australasian bittern, black bittern and comb-crested jacana are listed as vulnerable and the Australasian bittern (*Botaurus poicilioptilus*), Australian painted snipe and black-necked stork as endangered under the NSW TSC Act, with the Australian painted snipe also listed as vulnerable under the Commonwealth EPBC Act.

All five of these species have potential to occur or occasionally visit wet areas within the study area. While habitat preferences differ between the species, suitable potential habitat within the study area includes swamps, creeklines, floodplains, vegetated dams and other wet areas.

The Australasian bittern generally favours permanent, vegetated, shallow freshwater or brackish swamps (Garnett 1992). The black bittern is known to inhabit mangroves, reedy swamps and streamside vegetation including small creeks in forested land (Simpson and Day 2003). The painted snipe generally occurs in shallow, vegetated wetlands, particularly the fringes of swamps, dams and nearby marshy areas (DECCW threatened species profile). The black-necked stork is known from permanent freshwater wetlands, including swamps, floodplains and occasionally mangroves or estuarine areas (DECCW threatened species profile). The comb-crested jacana inhabits swamps, lakes and lagoons with floating vegetation on which it walks and forages (Simpson and Day 2003).

Only one of these species, the black-necked stork, has been previously recorded within the Project flying over the Stoney Creek Water Sports Park on the Wilson River floodplain. This observation is north of Lot 1 DP 624217. Areas of suitable habitat for wetland birds occur in vegetated swamps, dams and creeklines throughout the study area this including lands within Lot 1 DP 624217.

The Proposal is unlikely to displace any of these threatened wetland bird species. No direct impacts on freshwater wetlands are predicted within the study area, although, it must be noted that these habitats will directly adjoin the western edge of the proposal after its construction. These areas provide potential foraging habitat for the black-necked stork and could also be utilised by the painted snipe. The Australasian bittern, black bittern and comb-crested jacana are less likely to occur in these floodplain areas as a result of the open environment and lack of permanent open water, but could potentially be impacted by changes to water quality in creeks, permanent pools and waterways within the study area. In addition, occasional vehicle strikes could occur if any of these species are foraging near the road.

Yellow-bellied glider (*Petaurus australis*) – vulnerable under the NSW TSC Act

The yellow-bellied glider occurs in tall, mature wet eucalypt forest and is distributed along eastern Australia from Portland, Victoria, to central coastal Queensland. During the day the yellow-bellied glider rests in a den in a hollow branch, usually in a living, smooth-barked eucalypt. It emerges at night to forage, sometimes travelling more than 2 kilometres from the den site. The yellow-bellied glider feeds on plant and insect exudates (sap, nectar, honeydew and manna), with eucalypt blossom providing a valuable food resource when available and insects, spiders and pollen providing most of the protein in the diet (Russell 1995). The usual home range of the species is between 20 hectares and 85 hectares (DECCW threatened species profile).

This species was not recorded within during the survey of the study area however this species is known to occur along the length of the Proposal (GHD, 2010a). This species occurs within 2 kilometres of the Proposal with potential habitat for the yellow-bellied glider occurring throughout the study area, particularly at Stumpy Creek. This species is reliant upon hollow-bearing trees for roosting and breeding purposes and requires a reasonable level of vegetation connectivity in order to move freely from one area to another. Listed below are the tree species known to be utilised by the yellow-bellied glider for sap-feeding on the north coast (DECCW threatened species profile) that were recorded in the study area are:

- *Corymbia intermedia* (pink bloodwood).
- *Corymbia maculata* (spotted gum).
- *Eucalyptus amplifolia* (cabbage gum).
- *Eucalyptus grandis* (flooded gum).
- *Eucalyptus pilularis* (blackbutt).
- *Eucalyptus propinqua* (small-fruited grey gum).
- *Eucalyptus punctata* (grey gum).
- *Eucalyptus saligna* (Sydney blue gum).

- *Eucalyptus signata* (scribbly gum).
- *Eucalyptus tereticornis* (forest red gum).
- *Lophostemon confertus* (brush box).

Potential impacts associated with the Proposal include the loss of potential roosting and breeding hollows, the loss of potential foraging habitat (including the loss of potential food trees) and the further fragmentation of habitat associated with the proposed widening of the highway. Barriers could potentially result in an adjustment to individual yellow-bellied glider home ranges. or could result in increased road mortality from increased risk of vehicle strike.

The yellow-bellied glider has been recorded gliding distances of up to 140 metres depending on the height of the launch tree however average glide distances are likely to be significantly less than this (DECCW threatened species profile). Currently, the width along the highway varies between 20 metres to 40 metres for most of its length. The area of presumed impact for the Proposal varies in width from approximately 70 metres to well over the 140 metres maximum glide distance for the yellow-bellied glider.

A recovery plan for the yellow-bellied glider has been prepared (NPWS 2003d). As the Proposal is expected to result in the loss and further fragmentation of yellow-bellied glider habitat, it is therefore considered to be inconsistent with the objectives of the recovery plan for this species. Mitigation including the establishment of glider poles and rope ladders at specific corridor locations such as Stumpy Creek would reduce the potential for significant disruption to local yellow-bellied glider populations.

b) How is the Proposal likely to affect the habitat of a threatened species, endangered population or endangered ecological community?

The Proposal is mainly expected to affect threatened fauna habitat within the study area directly through native vegetation clearing, this including foraging and breeding habitat for many species, and indirectly through increased risk of vehicle strike. The majority of the impacts will be greatest felt at Stumpy Creek where a regional corridor coincides with vegetation loss, tree hollow loss and impacts on riparian environments.

No threatened flora species habitat is likely to experience a significant adverse impact by the Proposal for the study area. Impacts are restricted to the loss of potential habitat. Indirect impacts including stormwater management and invasive weeds represent important considerations over the long term.

No threatened fauna species reliant on aquatic habitats were not recorded within the study area survey such as the green and golden bell frog and the southern myotis. Changes in water quality remain the greatest risk to these species, these being potential indirect impacts for consideration. Mitigation that controls sediment and erosion is required to manage this issue. On this basis there is a low potential for an adverse impact on these species within the study area.

However, the Proposal is expected to affect riparian habitat within the study area that represents suitable for the green-thighed frog and giant barred frog. Local records for these species indicate a higher potential for occurrence in habitat found at Stumpy Creek. Potential impacts include pollution and sediment runoff into waterways and the loss and disturbance of riparian vegetation. These two species are likely to be sensitive to changes in water quality and require suitable riparian vegetation cover (including leaf litter). Mitigation including the management of sediment and erosion, habitat intrusions, habitat restoration, monitoring and improvements to movement pathways (i.e. beneath Stumpy Creek bridge) would substantially minimise the risk of an adverse impact on these species.

Due to the extent of vegetation clearing required, the Proposal is expected to result in the loss of known or potential habitat for a large number of threatened fauna species. The table below shows the extent of each native vegetation community likely to be affected as a result of the Proposal within the study area and the threatened fauna species with potential to occur in each community.

Extent of potential threatened fauna habitat loss associated with the Proposal

Vegetation community	Threatened fauna with potential to occur within the study area	Predicted impact area (hectares)
3-Paperbark Swamp Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, eastern chestnut mouse, owls, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider, wallum froglet.	1.7
5-Swamp Oak Forest	Barred cuckoo-shrike, insectivorous bats, owls, koala, square-tailed kite.	0.8
6-Wetland	Giant dragonfly, southern myotis, Australasian bittern, Australian painted snipe, black-necked stork, comb-crested jacana.	0.1
7-Moist Floodplain Forest	Insectivorous bats, common planigale, owls, glossy black-cockatoo, green-thighed frog, grey-crowned babbler, grey-headed flying-fox, koala, pale-headed snake, spotted-tailed quoll, square-tailed kite, squirrel glider, yellow-bellied glider.	1.2
8-Moist Gully Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, owls, fruit-doves, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, pale-headed snake, spotted-tailed quoll, square-tailed kite, squirrel glider, Stephens' banded snake, yellow-bellied glider.	1.6
10-Dry Ridgetop Forest	Brush-tailed phascogale, insectivorous bats, owls, glossy black-cockatoo, grey-crowned babbler, grey-headed flying-fox, koala, large-eared pied bat, pale-headed snake, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider.	0.4
Total		5.8

The loss of vegetation within the study area as a consequence of the Proposal would include the loss of particular tree species that provide important foraging habitat for a number of threatened fauna species. These include preferred food tree species for the koala, yellow-bellied glider and glossy black-cockatoo.

In addition to the loss of foraging habitat for the species in the above table, the clearing of vegetation associated with the Proposal is also expected to result in the loss of sheltering and breeding habitat for a number of these species, particularly due to the loss of hollow-bearing trees. While hollow-bearing trees were generally sparsely distributed throughout the study area, the large clearing footprint of the Proposal would result in the overall loss of a large number of hollow-bearing trees. Threatened species occurring, or considered likely to occur, within the study area that utilise hollow-bearing trees for sheltering and / or breeding purposes include the brush-tailed phascogale, forest owls, glossy black-cockatoo, hollow-roosting bats, pale-headed snake, southern myotis, spotted-tailed quoll, squirrel glider, Stephens' banded snake and yellow bellied glider.

Hollow logs and fallen timber provide potential habitat for a number of threatened fauna species, including the brush-tailed phascogale, common planigale and spotted-tailed quoll. Most areas of native vegetation within the study area contained some degree of fallen timber however these habitat features were most prevalent in more mature, unlogged bushland. Given the large clearing footprint, a large extent of fallen timber is expected to be removed as a result of the Proposal.

As the Proposal may affect bridges within the study area, bat species that roost under bridges and culverts may be affected by the Proposal, including the eastern bent-wing bat, little bent-wing bat and southern myotis. Of these three species, the bent-wing bats are likely to only roost in small numbers under bridges and culverts within the study area, though if these structures are removed while bats are roosting, then individual deaths may occur.

c) Does the Proposal affect any threatened species or endangered population that are at the limit of its known distribution?

The study area is nearing the southern limit for the common planigale, though records of the species do occur further south. It is also at the southern limit for the barred cuckoo-shrike, with only two isolated records of this species occurring south of Port Macquarie (near Stroud). Records of the rose-crowned fruit-dove, superb fruit-dove and wompoo fruit-dove do occur further south of the study area, but they are all more common further north and the study area lies near the southern end of their general distribution. None of these species was recorded during the field survey though potential habitat occurs. The Proposal is expected to result in the loss of potential habitat for these species, though not to the extent that a range reduction would result.

No other subject species are at the limit of their known distribution.

d) How is the Proposal likely to affect current disturbance regimes?

Current disturbance regimes within the study area include:

- Grazing.
- Linear infrastructure such as the existing highway corridor and local road network.
- Clearing for agriculture and new development.
- Logging.
- Agricultural activities.
- Quarrying.
- Roadside disturbance.

- Weeds.
- Feral animals.
- Runoff from roads, houses, industrial and agricultural areas.

The Proposal would result in a cumulative loss of native vegetation this increasing the propensity for weed invasion, particularly where the proposed alignment encroaches further into undisturbed vegetation (for example, Stumpy Creek). The Proposal is also expected to increase the area of roadside disturbance such as noise, litter and pollutants from traffic movements and accidental spills.

The effects of current disturbance regimes can be minimised by the use of appropriate ameliorative measures during the construction period such as soil management including stabilisation and control of runoff and revegetation of bare earth stockpile. Weed control programs including wash down procedures would also be considered to minimise the spread of weeds into undisturbed bushland. The use of permanent fencing to exclude access to the roadside shoulder would reduce the potential for unanticipated damage to peripheral bushland by construction works and the public. Ongoing weed management of the roadside verges is also considered an appropriate long term management process that would reduce the affect of current disturbance regimes by maintaining high value native vegetation cover.

e) How is the Proposal likely to affect habitat connectivity?

The Proposal is expected to result in the removal of native vegetation from within the study area, including the removal of vegetation from within mapped areas of key habitat and wildlife corridors. While the existing highway currently presents a barrier to fauna movement, further widening and roadside vegetation clearance by the Proposal is likely to increase the barrier effect of the highway. These impacts are also expected along the study area, with the greatest impact expected at Stumpy Creek.

Barrier effects are likely to impact on threatened fauna species, including the brush-tailed phascogale, common planigale, eastern chestnut mouse, koala, long-nosed potoroo, pale-headed snake, spotted-tailed quoll, squirrel glider, Stephens' banded snake and yellow-bellied glider. Two of these species, the koala and yellow-bellied glider, have been previously identified during prior surveys for the Proposal (GHD, 2010a). Nearby records of the brush-tailed phascogale, common planigale and spotted-tailed quoll increase the weight of consideration for these species (DECCW, 2010). Habitat for all these species is present throughout the study area although has not be validated through recent survey effort.

For non-gliding species, the existing highway already presents a risk of death or injury from vehicle strike (i.e. brush-tailed phascogale, common planigale, eastern chestnut mouse, koala, long-nosed potoroo, pale-headed snake, spotted-tailed quoll, squirrel glider, Stephens' banded snake). Road widening at Stumpy Creek and increased traffic counts and velocity on the service roads represent the main issues of concern. At Ravenswood Road a regional wildlife corridor is known to be used by the koala with changes in traffic counts and vehicle velocity potentially increasing the risk of death or injury from a vehicle strike. The Proposal would also widen the existing gap where an east west regional wildlife corridor coincides with Stumpy Creek. Again, while the existing highway already presents a barrier to koala movement, the proposed widening of the highway would increase this gap and decrease the effectiveness of these corridors in facilitating safe koala movement.

For gliding species, the existing highway is already likely to present some form of barrier to movement. Based on the concept design and width of the presumed impact area, the widening of the road corridor is expected to create/ exacerbate gap widths (i.e. Stumpy Creek and Lot 2 DP Lot 1 DP 624217) or increase the frequency of gaps (i.e. service roads) beyond the comfortable glide distance for both species along much of the study area. Both the yellow-bellied glider and squirrel glider would be adversely impacted by these changes, this necessitating the installation of fauna underpasses particularly at locations where the Proposal crosses regional corridors (i.e. Stumpy Creek).

Species with larger home ranges (particularly the brush-tailed phascogale and spotted-tailed quoll) increased gap creation within existing territories or movement pathways could potentially expose individuals to greater risk of road death and predation as they could potentially be forced to cross the new highway to move between foraging and shelter / roost habitat. The interruption of other lifecycle processes is also possible, this increasing the stress on individuals and populations.

Habitat connectivity for species such as the Australasian bittern, Australian painted snipe, black bittern, giant barred frog and stuttering frog is unlikely to be affected as these species would be able to cross under the new highway along riparian corridors or floodplain areas at bridge crossings. Frog species (in particular the green-thighed frog) that may periodically cross the highway during the breeding season or wet weather may be more susceptible to the risk of road death as a result of the road widening. Ameliorative measures such as underpasses and connecting turfed dish drains may assist in directing frogs under the road and avoid the risk of vehicle strike.

In summary, it is considered that the Proposal would create an increased barrier between areas of habitat for a number of threatened fauna species by isolating areas of habitat and increasing the distance between areas of remnant vegetation along mapped wildlife corridors within the study area. A number of measures may assist in ameliorating these impacts and reduce the risk of road deaths, including fauna underpasses and aerial rope crossings in association with floppy-top fencing. Roadside signs advising motorists of the presence of koalas may also assist in raising driver awareness of the need to drive carefully and watch out for animals crossing the road. The investigation of reduced speed limits at Rodeo Drive and its potential to reduce the incidence of vehicle strike for the koala is also recommended as a potential mitigation measure.

f) How is the Proposal likely to affect critical habitat?

No critical habitat is currently listed in the NSW TSC Act or Commonwealth EPBC Act for the subject species within the study area.

Conclusion to Part 3A Assessment for threatened fauna

Notwithstanding the impacts of the Proposal it is considered unlikely that the Proposal would result in impacts of the magnitude that would cause a local population of threatened fauna to become extinct. This conclusion is based on the following:

- Appropriate mitigation measures would minimise impacts on potential habitats for the koala, green-thighed frog and giant-barred frog, which have been identified as species' particularly vulnerable to potential impacts associated with the Proposal. For the koala, these measures include provision of fauna underpasses and fauna exclusion fencing. For green-thighed frog and giant barred frog, these measures include targeted surveys, a monitoring program, and consideration to construction of artificial habitat breeding ponds to provide alternative habitat. The location, size and design of these ponds would be considered at the detailed design and construction stages in consultation with DECCW, as discussed in the Working Paper (GHD, 2010a).
- Dedicated fauna underpasses, combined drainage / fauna movement culverts, aerial fauna crossings and glider poles in conjunction with wildlife exclusion fencing have been incorporated into the Proposal design to reduce the potential for adverse impacts on native wildlife as a result of habitat fragmentation barrier effects and road mortality.
- A range of pre-clearing survey protocols would be implemented during the construction phase of the Proposal, including inspections of hollow-bearing trees and staged clearing, to minimise the chances of death or injury to native fauna during the clearing and construction phases.
- The extent of habitat fragmentation caused by the Proposal, including at least two EECs, will be largely isolated to already disturbed roadside environments. Impacts on relatively unaffected vegetation at Stumpy Creek and Lot 1 DP 624217 would require the consideration of mitigation measures to maintain and improve habitat connectivity.

Appendix H

EPBC Act assessment

Assessment under the Commonwealth EPBC Act

Pursuant to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), an assessment of the impacts of the Proposal on land that is critical habitat or is likely to affect threatened species, populations, or ecological communities, or their habitats listed under the EPBC Act ('Matters of National Environmental Significance'), must be undertaken. This involves assessing the potential impacts of the Proposal based on several criteria. These criteria aid in assessing if the Proposal is likely to have a significant impact on threatened species or their habitat or endangered ecological communities which occur within the study or have the potential to occur. If the assessment concludes that a significant impact is likely then a referral to the Minister of the Department of Sustainability, Environment Water, Population and Community (SEWPAC) must be made. It should be noted that at this stage this checklist is part of a draft document, which is yet to be finalised. Therefore, the questions currently have no legal standing and are used here for guidance only.

Table 1 outlines the species for which an assessment has been completed:

Table 1 Species assessed under the EPBC Act

Group	Scientific Name	Common Name	EPBC Act Status
Threatened flora	*Acronychia littoralis*	scented acronychia	E
	Phaius tancarvilleae	swamp orchid	E
	Phaius australis	southern swamp orchid	E
	Arthraxon hispidus	hairy-joint grass	V
	Parsonsia dorrigoensis	milky silkpod	E
Threatened fauna	*Mixophyes iteratus*	giant barred frog	E
	Anthochaera phrygia	regent honeyeater	E
	Pseudomys novaehollandiae	New Holland mouse	V
	Lathamus discolor	swift parrot	E
	Dasyurus maculatus	spotted-tailed quoll	E
	Pteropus poliocephalus	grey-headed flying-fox	V
	Potorous tridactylus	long-nosed potoroo	V
	Litoria aurea	green and golden bell frog	V
	Chalinolobus dwyeri	large-eared pied bat	V
	Rostratula benghalensis	Australian painted snipe	V
	Mixophyes balbus	stuttering frog	V

Group	Scientific Name	Common Name	EPBC Act Status
Migratory fauna	*Ardea ibis*	cattle egret	M
	Monarcha melanopsis	black-faced monarch	M
	Gallinago hardwickii	Latham's snipe	M
	Pandion haliaetus	osprey	M
	Rhipidura rufifrons	rufous fantail	M
	Myiagra cyanoleuca	satin flycatcher	M
	Haliaeetus leucogaster	white-bellied sea-eagle	M
	Hirundapus caudacutus	white-throated needletail	M
	Rostratula australis	Australian painted snipe	M
	Apus pacificus	fork-tailed swift	M
	Ardea alba	great egret	M
	Merops ornatus	rainbow bee-eater	M
	Anthochaera phrygia	regent honeyeater	M
	Monarcha trivirgatus	spectacled monarch	M
	Lathamus discolor	swift parrot	M

Key:

V = Listed as a vulnerable species.

E = Listed as an endangered species.

M = Listed as a migratory species.

Threatened flora

No threatened flora was recorded within the study area during the field surveys. Notwithstanding there is potential habitat within the study area for five threatened flora species. These are assessed in the following sections.

Critically endangered and endangered flora species

Criteria

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- *Lead to a long-term decrease in the size of a population.*

It is unlikely that the Proposal would affect the size of any populations of the endangered species listed above since none were confirmed as occurring within the study area during the field surveys. In the unlikely event that there are unexpected finds of any of the listed endangered species within the study area prior to or during construction, the Proposal may lead to a minor decrease in the population size of these species through direct removal or through indirect impacts such as pollution, nutrient and sediment runoff.

- *Reduce the area of occupancy of the species.*

As no endangered species have been identified within the study area the Proposal is unlikely to reduce the area of occupancy of any endangered species.

- *Fragment an existing population into two or more populations.*

The Proposal is unlikely to fragment any population of endangered flora species in two or more populations as no threatened flora were recorded during field surveys within the Proposal footprint.

- *Adversely affect habitat critical to the survival of a species.*

The Proposal is unlikely to adversely affect habitat critical to the survival of any critically endangered or endangered species listed under the EPBC Act as no threatened flora were recorded during field surveys.

- *Disrupt the breeding cycle of a population.*

The Proposal is unlikely to disrupt the breeding cycle of any populations of endangered species as no threatened flora were recorded during field surveys within the Proposal footprint. However, if potential habitat for threatened flora is directly removed or becomes degraded, this could potentially disrupt the breeding cycle of a local population of this species.

- *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

The Proposal is unlikely to result in the overall decline of any endangered flora species listed on the EPBC Act as no threatened flora were recorded during field surveys within the Proposal footprint. However if potential habitat exists, unmitigated runoff from the Proposal during both construction and operation could indirectly affect threatened species associated with swamp habitats such as the swamp orchid and southern swamp orchid (if present). Sediment and erosion controls recommended as part of the mitigation measures for control and management of runoff would effectively prevent any significant indirect disturbances.

- *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 Proposal is unlikely to result in an increase in invasive species within the study area, provided effective weed management strategies are adopted.

- *Interfere with the recovery of the species.*

The Proposal is unlikely to significantly interfere with the recovery of any species.

*[*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation].*

Conclusion

The results of this assessment suggest that any impacts on endangered flora species listed on the EPBC Act resulting from the Proposal are unlikely to be significant.

Vulnerable flora species

Criteria

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- *Lead to a long-term decrease in the size of an important population[#] of a species.*

It is considered possible that one species listed as vulnerable under the EPBC may occur within the study area. This species, hairy-joint grass was recorded nearby the Proposal during prior field surveys. In the unlikely event that this species occurs within the study area, the degree of loss would be very minor and therefore unlikely to result in a long-term decrease of a local population of the species. Although threatened, this species is relatively robust in its growth habit and reproductive capabilities.

- *Reduce the area of occupancy of an important population.*

The Proposal is unlikely to reduce the area of occupancy for hairy joint grass as it considered unlikely to occur within the clearing footprint of the study area.

- *Fragment an existing important population into two or more populations.*

Since it is unlikely that hairy joint grass occurs within the study area, the Proposal is unlikely to fragment an existing important population of any vulnerable flora species into two or more populations.

- *Adversely affect habitat critical to the survival of a species.*

No occupied habitat for any EPBC listed vulnerable species was found to occur within the study area during the field surveys. The Proposal is unlikely to adversely affect habitat critical to the survival of any vulnerable flora species.

- *Disrupt the breeding cycle of an important population.*

Since no species listed as vulnerable under the EPBC Act are likely to occur within the clearing footprint, the Proposal is unlikely to disrupt the breeding cycle of an important population of any vulnerable flora species.

- *Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

The Proposal is unlikely to affect habitat for any vulnerable flora species. In the unlikely event that habitat for hairy-joint grass is modified, destroyed, removed, isolated or decreased, this would not occur to the extent that the species were likely to decline on a sustained or continuing basis.

- *Result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*.*

Disturbances associated with the Proposal could initiate conditions that facilitate invasions of exotic species. Significant weed invasions would also have the potential to degrade the habitat for threatened flora species if present. Threatened plants are highly vulnerable to invasions of introduced weeds, particularly lantana (*Lantana camara*), bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*) and exotic vines (DECC 2008). Uncontrolled construction works may also increase the risk of new invasions of exotic vines such as moth plant (*Araujia sericifera*), morning glory and mile-a-minute (*Ipomoea indica* and *I cairica*) which are known to occur within the study locality. However is effective weed management strategies are adapted it is unlikely that the proposal will result in invasive species becoming established within the study area.

- *Interferes substantially with the recovery of the species.*

While potential habitat for hairy-joint grass could be removed, the Proposal is unlikely to substantially interfere with the recovery of this species.

[#*An important population is one that is necessary for a species' long-term survival and recovery. This may include populations 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.*

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.*].

Conclusion

The results of this assessment suggest that any impacts on vulnerable flora species listed on the EPBC Act resulting from the Proposal are unlikely to be significant.

Threatened fauna

Critically endangered and endangered fauna species

No fauna species listed as critically endangered or endangered under the EPBC Act were recorded within the study area. However three endangered fauna species have been found within the study locality during previous surveys for the Proposal (the giant barred frog, swift parrot and spotted-tailed quoll).

The EPBC Act Protected Matters Search Tool identified one additional endangered species, the regent honeyeater, as having potential to occur within the study locality and suitable potential habitat was identified within the study area during the field surveys.

An assessment of significance pursuant to EPBC Act Policy Statement 1.1: Significant Impact Guidelines has been undertaken for those nationally listed endangered species recorded, or considered likely to occur. The specific EPBC Act criteria for determining whether the Proposal is likely to be considered a controlled action are addressed below:

Criteria

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- *Lead to a long-term decrease in the size of a population.*

The Proposal is unlikely to lead to a long-term decrease in the size of a population of the swift parrot or regent honeyeater. Both species are seasonal or opportunistic visitors to coastal NSW and forage in areas containing winter-flowering trees (for example, the swamp mahogany and spotted gum). Neither species was recorded during field surveys within the study area. The regent honeyeater is known to breed on the western slopes of the Great Dividing Range and the swift parrot breeds in Tasmania, as such breeding habitat for both species would not be impacted by the Proposal.

The Proposal is unlikely to lead to a long-term decrease in the size of a population of spotted-tailed quoll. This species was not recorded within the study area, though a few records occur nearby. DECCW's Atlas of NSW Wildlife indicates four main clusters of spotted-tailed quoll records (possibly sub-populations) associated with state forests and nature reserves located to the west side of the existing highway. Nearly all of the records are associated with creeklines within large patches of forest. East of the highway, the species appears to be generally absent, with only a few scattered records.

Road-related deaths are quite common for the spotted-tailed quoll, as the species often scavenges on road kill. The lack of database records along the existing highway suggests that the species is unlikely to use the highway corridor and adjoining habitats, particularly the drier ridgetop forests, on a regular basis, if it does at all. Furthermore, the current distribution of the species, as indicated by the existing records, suggests that core habitat for the species is not likely to be within habitats close to the highway and that the species is unlikely to move between habitats on each side of the highway on a regular basis.

Vegetation clearance resulting from the Proposal would be of a long, linear nature. The majority of clearing would be adjacent to the existing highway resulting in a further fragmentation of habitat, potential loss of den sites and a potential increase in the risk of road fatality.

- *Reduce the area of occupancy of the species.*

'Area of occupancy' is defined as the area within its 'extent of occurrence', which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases (for example, irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data.

As above, if areas of known habitat for the giant barred frog become degraded, this would reduce the area of occupancy of this species. Survey of the study area would indicate that the potential for a reduction of the area of occupancy for this species is unlikely (i.e. not detected during surveys). The Proposal is unlikely to reduce the area of occupancy of the swift parrot or regent honeyeater, though it would contribute to the incremental loss of potential foraging habitat affecting these species.

DECCW's Atlas of NSW Wildlife indicates four main clusters of spotted-tailed quoll records (possibly sub-populations) associated with state forests and nature reserves located to the west side of the existing highway. Nearly all of the records are associated with creeklines within large patches of forest. East of the highway, the species appears to be generally absent, with only a few scattered records.

A long strip of potential spotted-tailed quoll habitat is expected to be removed as a result of the Proposal. This may affect the home territories of some individuals of this species. The species has a very large home range and tends to favour denser habitats, particularly rainforest, moist sclerophyll forest and riparian forest along creeklines and gullies, rather than the more open dry sclerophyll forests on upper slopes and ridgelines. Notwithstanding the effect of any adjustments to the spotted-tailed quoll's home range within the study area is unlikely to result in a reduction in the area of occupancy of this species.

- *Fragment an existing population into two or more populations.*

Vegetation clearance resulting from the Proposal will be of a long, linear nature, however much of it is along the existing highway.

The Proposal is highly unlikely to fragment an existing population of either the swift parrot or regent honeyeater as both are mobile species that travel large distances every year and would easily be able to fly over the upgraded highway.

The giant barred frog is not known to occur within the study area however potential habitat at Stumpy Creek would be impacted. However, this impact is unlikely to fragment the known local population at the Maria River bridge crossing. The Proposal is highly unlikely to fragment an existing population of the giant barred frog into two or more populations as this species would be able to continue to cross the highway using the riparian corridor under bridge crossings.

Riparian corridors are favoured by the spotted-tailed quoll as foraging habitat, therefore if the species were to occur in the study area. This species often moves along vegetated creeklines and drainage lines, rather than through the drier more open habitats on the slopes and ridges. The DECCW data appears to support this, with nearly all of the records in the locality located along creeklines in the undulating terrain and ranges to the west of the existing highway. Potential habitat for the species is more likely to occur within riparian habitats such as those associated with the various creeks (including Stumpy and Cooperabung creeks).

The installation of fauna friendly passages at Stumpy creek under the bridge structure to allow terrestrial fauna, including the spotted-tailed quoll, to transit safely between habitats on either side of the highway would substantially reduce any cumulative fragmentation resulting from the Proposal.

Based on the above, it is considered unlikely that the Proposal will fragment any of the endangered species identified as potentially occurring within the study area into two or more populations.

- *Adversely affect habitat critical to the survival of a species.*

The Proposal would contribute to the incremental loss of potential foraging habitat affecting the swift parrot and regent honeyeater. However, no breeding habitat would be affected and the Proposal is considered highly unlikely to adversely affect habitat critical to the survival of either of these species.

While potential habitat for giant barred frog occurs at Stumpy and Cooperabung creeks, this species is unlikely to be reliant upon these sites for its survival. A threatened frog monitoring program targeting the giant barred frog would be established at Stumpy creek during, and following construction of the Proposal to determine the species persistence in the area and the success of the mitigation measures. Any habitat degradation resulting from the Proposal would have an impact on the local population of the giant barred frog, but would not result in the loss of the species.

Habitat resources critical to the survival of the spotted-tailed quoll are maternity den sites. Potential habitat and movement corridors for the spotted-tailed quoll occur at the Stumpy creek and Ravenswood Road sites. No latrine or den sites were recorded within the study area, rock shelters and small caves were absent and large logs were found to be sparsely scattered throughout the study area, generally in the more mature, unlogged bushland (of which little occurs within the study area). Little intact mature forest occurs within the study area and mature, hollow bearing trees tend to be confined to Lot 80 DP 7373735. It is therefore considered unlikely that the study area provides optimal denning habitat for spotted-tailed quoll.

- *Disrupt the breeding cycle of a population.*

The Proposal is unlikely to disrupt the breeding cycle of a population of the swift parrot or regent honeyeater. The regent honeyeater is known to breed on the western slopes of the Great Dividing Range and the swift parrot breeds in Tasmania. Both are seasonal or opportunistic visitors to coastal NSW and forage in areas containing winter-flowering trees (for example, the swamp mahogany and spotted gum). Neither of these species was recorded during the field survey, though both have potential to occur, particularly during peak winter flowering periods.

If giant barred frog habitat becomes degraded, particularly through changes to water quality, this could potentially disrupt the breeding cycle of the local population of this species. A threatened frog monitoring program targeting the giant barred frog would be established during, and following construction of the Proposal, focusing on areas of potential habitat within the Proposal footprint including Stumpy creek to determine the species persistence in the area and the success of the mitigation measures. The Proposal is therefore considered unlikely to disrupt the breeding cycle of a population of giant barred frog.

No spotted-tailed quoll den sites were recorded within the study area, rock shelters and small caves were absent and large logs were found to be sparsely scattered throughout the study area, generally in the more mature, unlogged bushland (of which little occurs within the study area). It is unlikely that the breeding cycle of the local population would be disrupted as the study area does not provide optimal denning habitat.

Mitigation designed to increase the certainty of these outcomes includes staged vegetation clearing; pre-clearing surveys to locate and inspect hollow logs for denning spotted-tailed quolls; and relocating hollow logs to adjacent habitat.

- *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

While the Proposal would contribute to the incremental loss of potential habitat affecting the swift parrot, regent honeyeater and spotted-tailed quoll, it is considered unlikely that this would result in the overall decline of any of these species.

In the absence of appropriate mitigation measures, there is some potential for construction works at Stumpy creek to decrease the quality of potential habitat for the giant barred frog. However, mitigation measures specifically addressing potential impacts on the species' habitat, including water quality impacts, will be developed and implemented as part of the Proposal.

The Proposal is therefore considered unlikely to modify, destroy, remove, isolate or decrease the available or quality of habitat to the extent that the regent honeyeater, swift parrot, spotted-tailed quoll and giant barred frog is likely to decline.

- *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*.*

The Proposal is unlikely to result in an increase in invasive species within the study area. Weed management plans are proposed, these designed to stop the further spread of weed species, introduction of new species and management of weeds in the post developed landscape.

- *Interfere with the recovery of the species.*

The Proposal is unlikely to result in the degradation of known threatened species habitat. Mitigation is proposed to restrict the impacts to the Proposal to the road corridor thus limit the potential for unintended or unexpected impacts. While the Proposal is unlikely to have a significant impact on the swift parrot, regent honeyeater or spotted-tailed quoll, the expected removal of a potential habitat would not be conducive to the recovery of these species.

[**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation*].

Conclusion

The Proposal is unlikely to have a significant impact on endangered fauna species listed under the EPBC Act. Mitigation and management measures have been developed in consultation with the relevant authorities to:

- Avoid inadvertent removal of spotted-tailed quoll den sites (if present), particularly those being used by a mother with young.
- Ensure areas of potential habitat for the giant barred frog do not become degraded through pollution, nutrient and sediment runoff or disturbance to riparian vegetation.
- Prevent individual giant barred frogs from accessing construction zones in areas of potential habitat.

On the basis of the assessments undertaken, it is concluded that the Proposal is unlikely to result in a significant effect on endangered species listed on the EPBC Act.

Vulnerable fauna species

One species listed as vulnerable, the grey-headed flying-fox was recorded along Cooperabung Drive during the survey of the study area. This species was also recorded at six additional sites along the entire Proposal alignment (GHD 2010a). One additional species, the green and golden bell frog, has been previously recorded within the study locality but not within the study area.

The EPBC Act Protected Matters Search Tool identified a further six species with potential to occur within the study locality these being the Australian painted snipe, stuttering frog, large-eared pied bat, brush-tailed rock-wallaby, new Holland mouse and long-nosed potoroo. Based on the results of field work and habitat assessment within the study area, all but the brush-tailed rock-wallaby have some potential to occur with the study area.

An assessment of significance pursuant to EPBC Act Policy Statement 1.1: Significant Impact Guidelines has been undertaken for those nationally listed vulnerable species, populations or ecological communities recorded, or considered likely to occur. The specific EPBC Act criteria for determining whether the Proposal is likely to be considered a controlled action are addressed below:

Criteria

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- *Lead to a long-term decrease in the size of an important population[#] of a species.*

Only one listed vulnerable species, the grey-headed flying-fox, was recorded within the study area during the field surveys. While the Proposal would result in a loss of a long strip foraging habitat, given the large home range and migratory habits of this species, it is unlikely that this would lead to a long-term decrease in the size of an important population of the grey-headed flying-fox.

The Australian painted snipe, green and golden bell frog, stuttering frog, large-eared pied bat, new holland mouse and long-nosed potoroo have some potential to occur within the study area. Of these species, only the green and golden bell frog has previously been recorded within the study locality. Given the lack of records and the fact that none of these species were recorded during field survey work, it is considered unlikely that an important population of any of these species occurs within the study area.

The Proposal is therefore considered unlikely to lead to a long-term decrease in the size of an important population of any vulnerable fauna species listed under the EPBC Act.

- *Reduce the area of occupancy of an important population.*

It is considered that the Australian painted snipe, green and golden bell frog, stuttering frog, large-eared pied bat, new Holland mouse and long-nosed potoroo do not have important populations occurring within the study area. While the Proposal would result in the loss of potential habitat, it is unlikely to reduce the area of occupancy of an important population of any of these species.

The grey-headed flying-fox is a highly mobile species and while the Proposal would contribute to the incremental loss of habitat affecting this species, it is highly unlikely to reduce the area of occupancy of an important population of the grey-headed flying-fox.

- *Fragment an existing important population into two or more populations.*

It is unlikely that an important population of the Australian painted snipe, green and golden bell frog, stuttering frog, large-eared pied bat, new Holland mouse and long-nosed potoroo occurs within the study area. The grey-headed flying-fox is known to occur, but as this is a highly mobile species, the Proposal is highly unlikely to fragment an existing important population of the grey-headed flying-fox into two or more populations.

The Proposal is therefore considered unlikely to fragment an existing important population of any vulnerable species listed under the EPBC Act into two or more populations.

- *Adversely affect habitat critical to the survival of a species.*

Potential habitat for the Australian painted snipe, green and golden bell frog, stuttering frog, large-eared pied bat, new Holland mouse and long-nosed potoroo within the study area. However, given that no known populations of these species occur within the study area, it is highly unlikely that the Proposal would adversely affect habitat critical to the survival of any of these species.

Foraging habitat for the grey-headed flying-fox would be lost as a result of the Proposal, however no known breeding or roosting habitat would be affected. While the loss of foraging habitat contributes to the incremental loss of habitat affecting this species, the Proposal is unlikely to adversely affect habitat critical to the survival of the grey-headed flying-fox.

- *Disrupt the breeding cycle of an important population.*

No known populations of the Australian painted snipe, green and golden bell frog, stuttering frog, large-eared pied bat, new Holland mouse and long-nosed potoroo occur within the study area. It is therefore considered highly unlikely that the Proposal would disrupt the breeding cycle of an important population of any of these species. The grey-headed flying-fox was recorded foraging within the study area during the field surveys, however the nearest known camps are at Sea Acres, Port Macquarie and Crescent Head, north of Kempsey. The Proposal is therefore highly unlikely to disrupt the breeding cycle of and important population of the grey-headed flying-fox.

- *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, green and golden bell frog, stuttering frog, large-eared pied bat, new Holland mouse and long-nosed potoroo would be affected as a result of the Proposal. However given that no known populations of these species occur within the study area, the Proposal is unlikely to affect any of these species to the extent that they would decline.

While foraging habitat for the grey-headed flying-fox is expected to be removed as a result of the Proposal, it is unlikely that this would affect the species to such an extent that it would decline.

- *Result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*.*

The Proposal is unlikely to result in an increase in invasive species within the study area. Weed management plans are proposed, these designed to stop the further spread of weed species, introduction of new species and management of weeds in the post developed landscape.

- *Interferes substantially with the recovery of the species.*

While the Proposal is unlikely to have a significant impact on any vulnerable species listed under the EPBC Act, the expected removal of a large area of potential habitat for vulnerable species would not be conducive to the recovery of these species.

[#*An important population is one that is necessary for a species' long-term survival and recovery. This may include populations 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.*

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.*]

Conclusion

On the basis of the assessments undertaken, it is concluded that the Proposal is unlikely to result in a significant effect on vulnerable species listed on the EPBC Act.

Migratory species

Two migratory species, the satin flycatcher and Latham's Snipe, were recorded within the study area during the survey period. An additional six species have been recorded within the study locality during prior surveys (GHD 2010a) although these were not observed within the study area. These were the black-faced monarch, cattle egret, osprey, rufous fantail, white-bellied sea-eagle and white-throated needletail. The EPBC Act 1999 Protected Matters Search Tool identified seven additional migratory species that have potential to occur within the study locality, the Australian painted snipe, fork-tailed swift, great egret, rainbow bee-eater, regent honeyeater, spectacled monarch and swift parrot. The specific EPBC Act criteria for determining whether the Proposal is likely to have a significant impact on any migratory fauna species are addressed below:

Criteria

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- *Substantially modify (including by fragmentation, altering fire regimes, altering nutrient cycles or altering hydrological cycles) destroy or isolate an area of important habitat* for a migratory species.*

The black-faced monarch, rufous fantail, satin flycatcher and spectacled monarch are found in a range of vegetation types, but tend to prefer moist forest habitats. Potential and known habitat within the study area does not support an ecologically significant proportion of the population of any of these species, is not of critical importance at any particular life-cycle stage to any of these species, is not at the limit of the species' range and is not in an area where any of these species is declining. While the Proposal would result in the loss of habitat for these species, these areas do not constitute 'important habitat' as defined by the EPBC Act.

During previous surveys the cattle egret and Latham's snipe were both observed in areas of open pasture and are most likely to inhabit the open grazing lands of the Wilson River floodplains (Lot 1 DP 624217). This was confirmed during the survey of the study area for the Latham's snipe. The Australian painted snipe and great egret were not recorded within the study area, but are known to occupy similar habitats. Latham's snipe breeds in the northern hemisphere while the cattle egret and great egret breed in colonies with other waterbirds in wetland areas. No cattle egret or great egret breeding sites are known to occur within the study area.

The Australian painted snipe nests on the ground in tall reeds or grasses near water. Some potential breeding habitat for this species does occur within Lot 1 DP 624217, however given that these areas are degraded and currently grazed by cattle, they are unlikely to represent 'important habitat' for the Australian painted snipe. While some habitat for these species may be destroyed or modified as a result of the Proposal, these areas do not qualify as 'important habitat' according to the EPBC Act definition of the term.

Ospreys and white-bellied sea-eagles feed mainly on aquatic animals and are unlikely to rely heavily upon terrestrial environments within the study area for foraging. No nest trees of either species were observed within the study area and the Proposal is unlikely to substantially modify, destroy or isolate an area of 'important habitat' for either of these species.

The rainbow bee-eater could potentially visit the study area. Potential foraging and breeding habitat for this species occurs within the study area and could be affected as a result of the Proposal. However as the rainbow bee-eater is a common, widespread species, it is considered highly unlikely that the Proposal would substantially modify, destroy or isolate an area of 'important habitat' for the rainbow bee-eater.

The regent honeyeater is known to breed on the western slopes of the Great Dividing Range and is highly unlikely to breed within the study area. One record of the regent honeyeater exists for the locality and this species could potentially forage on an opportunistic basis within the study area. The regent honeyeater is not likely to be a resident or regular visitor to the area and the habitats within the study area are highly unlikely to constitute 'important habitat' for this species. Similarly, swift parrot breeds in Tasmania and no breeding habitat would be impacted by the Proposal. There are seven records of the species from within the locality, and the species could potentially forage on an opportunistic basis within the study area. The swift parrot is not likely to be a resident or regular visitor to the area and the habitats within the study area are highly unlikely to constitute 'important habitat' for this species.

The white-throated needletail and fork-tailed swift would only fly over the study area and would not be affected by the Proposal.

The Proposal is therefore unlikely to substantially modify, destroy or isolate an area of important habitat for any migratory species listed under the EPBC Act.

- *Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.*

The Proposal is unlikely to result in any invasive species becoming established within the study area, provided effective weed management strategies are adopted.

- *Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion[#] of the population[+] of a migratory species.*

The black-faced monarch, rufous fantail, satin flycatcher and spectacled monarch are found in a range of vegetation types, but tend to prefer moist forest habitats. These species do not tend to congregate in large groups and the study area is highly unlikely to support at any lifecycle stage an ecologically significant proportion of the population of any of these species. While the Proposal could potentially result in the loss of habitat for these species, it is highly unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of any of these migratory species.

The cattle egret and great egret both congregate with other waterbirds to breed. No known breeding areas for either species occurs within the study area and none are likely to be affected by the Proposal. As both the cattle egret and great egret are common widespread species, it is considered highly unlikely that the study area would at any stage support an ecologically significant proportion of the population of either species.

Latham's snipe is a non-breeding migrant to Australia, it does not tend to congregate in large numbers and it is considered highly unlikely that the study area would at any stage support an ecologically significant proportion of the Latham's snipe population.

The Australian painted snipe was not recorded within the study area and no records exist for the locality. Some potential breeding habitat for this species does occur within Lot 1 DP 624217, however these areas are degraded and currently grazed by cattle. The Australian painted snipe does not tend to congregate in large numbers and given the marginal nature of the available habitat, it is unlikely that the study area would at any stage support an ecologically significant proportion of the Australian painted snipe population.

The osprey and white-bellied sea-eagle tend to occur in pairs and do not congregate in large groups. The study area is unlikely to provide nesting sites for these species and would not support an ecologically significant proportion of the population of either species.

The rainbow bee-eater was not recorded during the field surveys, though it could potentially visit the study area. The rainbow bee-eater is a common, widespread species and it is considered highly unlikely that the study area would support an ecologically significant proportion of the rainbow bee-eater population at any lifecycle stage.

The regent honeyeater and swift parrot is not likely to be a resident or regular visitor to the area and it is considered highly unlikely that the study area would at any stage support an ecologically significant proportion of the population of this species.

The white-throated needletail and fork-tailed swift would only fly over the study area and would not be affected by the Proposal.

The Proposal is therefore unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of any migratory species listed under the EPBC Act.

[* *An area of 'important habitat' for a migratory species is:*

- *Habitat utilised by a migratory species occasionally or periodically within the region that supports an ecologically significant proportion of the population of the species; and/or*
- *Habitat that is of critical importance to the species at particular life-cycle stages; and/or*
- *Habitat utilised by a migratory species which is at the limit of the species range; and/or*
- *Habitat within an area where the species is declining.*

[#] *Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).*

[+] *'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.*]

Conclusion

In summary, while the Proposal is expected to result in the loss of habitat for some of these species. However, based on the criteria outlined above, the Proposal is considered unlikely to have a significant impact on any migratory species listed under the EPBC Act.

Places on the Register of the National Estate

Two places on the Register of the National Estate (RNE) occur within the study locality, Pipers Creek Lime Kllins and Limeburners Creek Nature Reserve. Neither of these places is likely to be impacted by the proposal.

Conclusion to the EPBC Act assessment

The Proposal is unlikely to have a significant impact on endangered fauna species listed under the EPBC Act, provided that adequate mitigation and management measures are developed in consultation with the relevant authorities at the detailed design stage to:

- Avoid inadvertent removal of spotted-tailed quoll den sites (if present), particularly those being used by a mother with young.
- Ensure areas of habitat for the giant barred frog do not become degraded through pollution, nutrient and sediment runoff or disturbance to riparian vegetation.
- Individual giant barred frogs are prevented from accessing construction zones in areas of potential habitat.

On the basis of the assessments undertaken, it is concluded that the Proposal is unlikely to impose a significant effect on threatened and migratory species listed on the EPBC Act, provided that proposed mitigation and management measures are developed and implemented.

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