



Transport
Roads & Traffic
Authority

Oxley Highway to Kempsey

Upgrading the Pacific Highway
Environmental assessment
submissions report

MARCH 2011

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Roads and Traffic Authority

Pacific Highway Upgrade - Oxley Highway to Kempsey

Submissions Report

14 March 2011

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Appendix: B	Supplementary Flora and Fauna Assessment
Appendix: C	Median Widening Assessment – Preliminary Scoping Investigation

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I Introduction and background

1.1 The project

The Oxley Highway to Kempsey Pacific Highway upgrade, (the 'Proposal') is part of the Pacific Highway Upgrade Program being implemented by the NSW Roads and Traffic Authority (RTA).

The Proposal is 37 kilometres in length, commencing approximately 700 metres north of the Oxley Highway interchange, tying in with the existing dual carriageways to the south, and continues northwards to tie in at Stumpy Creek with the dual carriageways of the approved Kempsey to Eungai Pacific Highway upgrade currently under construction. 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 Kempsey bypass section of the approved Kempsey to Eungai upgrade. The majority of the Proposal (20 kilometres) would be a duplication of the existing Pacific Highway. Three sections of the Proposal would deviate from the alignment of the existing highway. These are in the vicinity of the Hastings River (four kilometre deviation), a bypass of Telegraph Point (eight kilometre deviation) and through the Maria River State Forest (five kilometre deviation). The existing highway would be retained wherever possible for use as a service road or local road connection.

A detailed description of the Oxley Highway to Kempsey Pacific Highway upgrade is found in the Oxley Highway to Kempsey Environmental Assessment prepared by RTA in September 2010.

1.2 Statutory context

The Minister for Planning has declared by Order published on 8 December 2006 in the NSW Government Gazette No. 175 2006 that the Oxley Highway to Kempsey Pacific Highway upgrade is a project to which Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) applies. The Minister has also declared that the Oxley Highway to Kempsey Pacific Highway upgrade is a critical infrastructure project under section 75B of the EP&A Act.

In accordance with the requirements of the EP&A Act, an environmental assessment was prepared to assess the potential impacts of the project.

1.3 Environmental assessment exhibition

The environmental assessment was exhibited for 30 days from 15 September 2010 to 15 October 2010 at the following locations:

- NSW Department of Planning, Information Centre, 22-33 Bridge Street, Sydney.
- Kundabung Post Office, 100 Ravenswood Road, Kundabung.
- Telegraph Point Post Office, 21 Cooperabung Drive, Telegraph Point.
- Port Macquarie Library, Corner Gordon and Grant streets, Port Macquarie.
- Port Macquarie-Hastings Council, Corner Lord and Burrwan streets, Port Macquarie.
- Kempsey Council Chambers, 22 Tozer Street, West Kempsey.
- Kempsey Library, 15 Elbow Street, Kempsey.
- RTA Motor Registry, 55 Elbow Street, Kempsey.
- RTA Motor Registry, Corner Central Road and Barton Crescent, Port Macquarie.
- RTA Motor Registry, Corner Hastings and Young streets, Wauchope.
- RTA Pacific Highway Office, 21 Prince Street, Grafton.
- RTA Head Office, Level 9, 101 Miller Street, North Sydney.

All necessary reference material was made available for review at the nominated locations and the environmental assessment was also available on the NSW Department of Planning (DoP) and the NSW Roads and Traffic Authority (RTA) websites.

Property owners directly affected by the Proposal were sent a letter on 10 September 2010 inviting them to meet with representatives of the project team to discuss the potential impacts of the Proposal on their property. Also included with the letter was a community update and electronic copies of the environmental assessment. The project team endeavoured to telephone all directly affected landowners during the exhibition period.

Community updates were also sent to adjacent land owners and local residents.

The RTA hosted two staffed displays during the exhibition period at the Telegraph Point School of Arts. These displays were held between 16 and 18 September 2010 and 12 and 13 October 2010. The purpose of these sessions was to give local residents the opportunity to ask the project team any questions regarding the Proposal.

Approximately 144 community members attended the displays over the five days.

Representatives of the project team also held individual meetings with directly affected landowners or those close to the Proposal.

Representatives of the project team also met with the community liaison and ecology focus groups during the evening of 15 September 2010. This meeting was convened early on in the environmental assessment exhibition period to allow for input from these members with a specific interest in these topics. It also allowed the RTA to explain the methodology used in the environmental assessment for ecology and to discuss the key outcomes of those investigations.

Project team members also attended a meeting of the Telegraph Point Community Association on the evening of 12 October 2010 to present the environmental assessment and answer enquiries about the project.

1.4 Purpose of the document

During the exhibition of the environmental assessment, 147 submissions were made by individuals, organisations, local government and NSW Government agencies. The Director-General of the Department of Planning (DoP) provided copies of the submissions to the RTA.

In accordance with section 75H(6) of the *Environmental Planning and Assessment Act 1979*, the Director-General required the RTA to respond to the issues raised in these submissions. If there were any changes to the project to minimise environmental impacts, the Director-General required the preparation of a preferred project report and a revised Statement of Commitments (SoC).

This report identifies the issues raised during exhibition of the environmental assessment and provides the RTA's responses to those issues (section 2). It includes information regarding additional studies carried out since the exhibition of the environmental assessment (section 3), and a revised Statement of Commitments (section 4).

No project changes are proposed that would require the preparation of a preferred project report.

1.5 Respondents

The Department of Planning (DoP) received 147 submissions in response to the exhibition of the environmental assessment. The DoP continued to receive submissions after the closing date and provided the RTA with the final community submission on Thursday 4 November 2010. The last government agency submission was received on 25 November 2010. There were:

- 139 submissions from private individuals, of which 92 were form letters in support of the Proposal and 47 letters and e-mails. One individual requested that their details remain confidential.
- Eight submissions from government agencies including Transport NSW, Department of Environment, Climate Change and Water (DECCW), Industry and Investment NSW, Office of Water, Northern Rivers Catchment Management Authority, Kempsey Shire Council, Port Macquarie - Hastings Council and Forests NSW.

The issues raised in each submission were extracted and collated, and corresponding responses to the issues provided. Where similar issues have been raised in different submissions, only one response has been provided. The issues raised and the RTA's response to these issues forms the basis of Section 2 of this report.

Table 1.1 lists each submission by number and indicates which section of the report addresses the issues raised in the submission.

Table 1.1: List of respondents

Respondent	Submission No.	Section number where issues are addressed
Individual submission	1	2.5.3, 2.8.3
Individual submission	2	2.5.3.1, 2.8.3, 2.8.4, 2.12.1, 2.15.1
Individual submission	3	2.8.2, 2.9.1, 2.13.1, 2.14.1, 2.7.1
Individual submission	4	2.1, 2.4, 2.7, 2.9.1, 2.12.2, 2.13.3, 0, 2.16
Individual submission	5	2.6.1, 2.8.4, 2.9.1, 2.11, 2.13.1, 2.15.1, 2.15.2, 2.15.4
Individual submission	6	2.7.1, 2.8.4, 2.9.1, 2.12.1, 2.5.3.1
Individual submission	7	2.8.3
Individual submission	8	2.5.1, 2.7.1, 2.9.1, 2.5.3.1
Individual submission	9	2.7.2, 2.8.1, 2.8.2
Individual submission	10	2.4, 2.7.3, 2.8.2, 2.8.3, 2.13.1, 2.14.1, 2.5.3.1, 2.15.4
Individual submission	11	2.4, 2.9.1, 2.7.3, 2.11, 2.17
Individual submission	12	2.5.3.1
Individual submission	13	2.12.1, 2.5.3.1
Individual submission	14	2.8.2, 2.8.4, 2.5.3.1
Individual submission	15	2.7.1, 2.7.3, 2.8.3, 2.8.4, 2.13.3, 2.5.3.1
Individual submission	16	2.4, 2.5.1
Individual submission	17	2.8.3, 2.13.3
Individual submission	18	2.5.1, 2.5.2, 2.8.2, 2.15.4
Individual submission	19	2.4, 2.5.1, 2.5.3.1, 2.7.4
Individual submission	20	2.7.1, 2.8.3, 2.13.1, 2.15.1
Individual submission	21	2.5.1, 2.7.2, 2.13.1
Individual submission	22	2.4, 2.5.3.1, 2.6.2, 2.7.2, 2.7.3, 2.8.3, 2.8.4, 2.13.3, 2.14.1, 2.15.4
Individual submission	23	2.8.1, 2.8.2, 2.13.2
Individual submission	24	2.5.3.1, 2.7.4
Individual submission	25	2.5.3.1, 2.7.4, 2.8.2, 2.13.3, 2.17, 2.19
Individual submission	26	2.15.2
Individual submission	27	2.9.1, 2.15.4

Respondent	Submission No.	Section number where issues are addressed
Individual submission	28	2.3, 2.5.1, 2.7.2, 2.15.4
Individual submission	29	2.3, 2.4, 2.12.3, 2.12.4
Individual submission	30	2.1, 2.5.3.1, 2.7.1, 2.8.2, 2.8.4, 2.9.1, 2.13.2, 2.15.4
Individual submission	31	2.6.1, 2.8.3, 2.15.1
Individual submission	32	2.4, 2.7.3, 2.13.2, 2.14.1
Individual submission	33	2.5.1, 2.13.2
Individual submission	34	2.4, 2.12.3
Individual submission	35	2.5.1, 2.7.2, 2.9.1, 2.13.2, 2.14.1, 2.17
Individual submission	36	2.5.1, 2.5.3.1
Individual submission	37	2.5.1, 2.5.3.1
Individual submission	38	2.3, 2.7.1
Individual submission	39	2.3, 2.7.1, 2.8.2
Individual submission	40	2.3, 2.5.1, 2.5.3, 2.7.1, 2.8.2
Individual submission	41	2.1, 2.4, 2.5.1, 2.12.1, 2.12.2, 2.12.3, 2.12.4, 2.18
Individual submission	42	2.5.1, 2.7.2, 2.8.3, 2.9.1, 2.10, 2.12.2, 2.12.3, 2.13.1, 2.15.2
Individual submission	43	2.3, 2.7.2, 2.7.4, 2.8.2
Individual submission	44	2.3
Individual submission	45	2.3, 2.5.3.1, 2.13.3, 2.14.1
Individual submission	46- 134	2.3
Transport NSW	135	2.15.2
NSW Department of Environment, Climate change and Water	136	2.12.1, 2.12.2, 2.12.3, 2.12.4, 2.12.5, 2.13.1, 2.13.2, 2.13.3, 2.17, 2.18, 2.19, 2.20
Industry and Investment NSW	137	2.7.2, 2.8.1, 2.8.2, 2.12.2, 2.20
Kempsey Shire Council	138	2.5.1, 2.7.4, 2.8.2, 2.9.1, 2.12.1, 2.15.4
Northern Rivers Catchment Management Authority	139	2.10, 2.12.2, 2.12.4, 2.12.5
Port Macquarie - Hastings Council	140	1.6.3
NSW Office of Water	141	2.2, 2.10, 2.11, 2.15.2, 2.20
Individual submission	142	2.5.3.1, 2.8.2
Individual submission	143	2.4, 2.5.3.1, 2.8.3, 2.9.1, 2.13.3, 2.14.1, 2.16
Individual submission	144	2.3
Individual submission	145	2.3
Individual submission	146	2.3
Forests NSW	147	2.5.3.1, 2.7.1, 2.7.4

1.6 Overview of the issues raised

Of the 147 submissions, 101 community submissions (including 92 form letters) supported the Proposal, whilst three community submissions objected to the Proposal. 43 submissions raised concerns or questions about the Proposal.

Submissions received from the government agencies focussed predominantly on their particular area of statutory or advisory responsibility. Some of the agency submissions also made recommendations for conditions of approval and amendments to the statement of commitments.

A summary of the issues raised in business and community submissions and by each government agency is presented below.

1.6.1 Businesses and community submissions

Submissions from businesses and individual community members were predominantly concerned with property impacts: including acquisition, noise, land use, flooding, privacy and access arrangements.

1.6.2 Kempsey Shire Council

Kempsey Shire Council (KSC) raised a number of issues regarding, fauna movement, property and business access, impacts on businesses, flooding and transport impacts associated with the Proposal. KSC also asked for clarification of several design issues.

Table 1.2 provides details of the categories of issues raised by KSC and where these issues have been responded to in this report.

Table 1.2: Issues raised by KSC

Issue	Report section where issues are addressed
Design	2.5.1
Land use and property	2.7.4
Social and economic	2.8.2
Hydrology	2.9.1
Flora and fauna	2.12.1
Traffic and transport	2.5.3.1, 2.15.4

1.6.3 Port Macquarie - Hastings Council

Port Macquarie - Hastings Council did not identify any issues of concern or requirement for special conditions of approval.

1.6.4 Department of Environment, Climate Change and Water

The Department of Environment, Climate Change and Water's (DECCW) submission provided comments on key issues, including water, flora and fauna, noise and vibration and Aboriginal heritage. An important focus of the submission was the sizing and location of water quality controls, validation of noise modelling and proposed mitigation measures including flora and fauna connectivity.

Table 1.3 provides further details of the categories of issues raised and where they have been responded to within this report. Issues raised by the DECCW will be further discussed with the department. Where necessary any changes have been captured in the revised statement of commitments (section 4).

The DECCW expressed a preference for the majority of the issues raised in its submission to be addressed in a revised statement of commitments. This submissions report addresses the issues raised in the DECCW submission and the statement of commitments (section 4) has been revised to include appropriate changes.

Table 1.3: Issues raised by DECCW

Issue	Report section where issues are addressed
Project support	2.3
Water quality	2.10
Flora and fauna	2.12.1, 2.12.2, 2.12.3, 2.12.4, 2.12.5
Noise and vibration	2.13.1, 2.13.2, 2.13.3
Geology and soils	2.17
Clarifications to the environmental assessment	2.19
Statement of commitments	2.20

1.6.5 Industry and Investment NSW

The submission from Industry and Investment NSW (I&I NSW) focused on potential land use issues and impacts on aquatic habitats.

Table 1.4 provides details of the categories of issues raised by I&I NSW and where these issues have been responded to in this report.

Table 1.4: Issues raised by I&I NSW

Issue	Report section where issues are addressed
Land use and property	2.7.2
Social and economic	2.8.1, 2.8.2
Flora and fauna	2.12.2
Statement of commitments	2.20

1.6.6 NSW Office of Water

NSW Office of Water's (NOW) submission focused on the licence and approval requirements during construction. Other issues raised include water quality and hydrology in relation to acid sulphate soil disturbance. A number of recommendations were also provided for the statement of commitments, which NOW advised should also be incorporated into the conditions of approval.

Table 1.5 provides details of the categories of issues raised by the NOW and where these issues have been responded to in this report.

Table 1.5: Issues raised by NOW

Issue	Report section where issues are addressed
Licensing	2.2
Water quality	2.10
Groundwater	2.11
Statement of commitments	2.20

1.6.7 Forests NSW

The submission from Forests NSW focused on acquisition, potential land use issues and traffic and transport.

Table 1.6 provides details of the categories of issues raised by Forests NSW and where these issues have been responded to in this report.

Table 1.6: Issues raised by Forests NSW

Issue	Report section where issues are addressed
Land use and property	2.7.1, 2.7.4
Traffic and transport	2.15.4

1.6.8 Transport NSW

Transport NSW requested that relevant public transport and school bus providers be consulted, that 2.5m wide shoulders along the Proposal are maintained on bridges and at pinch points to minimise conflict between cyclists and vehicles and that opportunities to provide cycle way connections to adjoining communities be investigated. A response to these issues is provided in section 2.15.2 of the submissions report.

1.6.9 Northern Rivers Catchment Management Authority

The issues raised by the Northern Rivers Catchment Management Authority (NRCMA) relate to water quality and flora and fauna. A response to these issues is provided in sections 2.10 and 2.12 of the submissions report.

2 Response to issues

2.1 Alternatives considered and route development

Submission numbers

- 4 – Individual
- 30 – Individual
- 41 – Individual

Issue description

Three community submissions raised concerns in relation to the alternatives considered in developing the Proposal.

- 1) One community submission raised concerns about the Proposal alignment at the Hastings River crossing and suggested the RTA decision on the route for the crossing was influenced by a proposed marina precinct adjacent to Hastings River.
- 2) One community submission suggested that environmental issues, in particular potential damage to Endangered Ecological Communities (EECs), were not given enough importance when assessing route options during the Value Management Workshop. The respondent also suggested that cost should not be the critical factor in determining the route and offsets should be the last choice.
- 3) One community submission stated that inadequate information has been provided to explain the decision to open Wyndell Close to traffic as part of the Proposal.

Response

- 1) The route selection process has been discussed in section 3.3 of the environmental assessment and additional information on this process can be found in *The Preferred Route Option Report (NSW Roads and Traffic Authority 2006)*. The preferred route was selected following extensive consultation with the community and evaluation of all route options using a range of environmental, engineering, social, safety and cost criteria. It was considered that the preferred route achieved the best balance between environmental, social, engineering and economic constraints and opportunities.

Minimising potential impacts on private property and existing business operations was a key consideration during the route selection process. The proposed marina precinct adjacent to the Hastings River was not identified during the route selection process and the preferred route was not influenced by the proposed marina precinct.

The cost of constructing the Hasting River bridges was considered as part of the route development process, along with other environmental, socio-economic and functional issues. On balance, the preferred route is considered to provide the best overall outcome.

- 2) The Value Management Workshop is one part of the route selection process. During the workshop several environmental, engineering, socio-economic, safety and cost issues were used to evaluate each of the options. The results of this workshop were used along with other investigations to assist the RTA in determining the preferred route. Minimising environmental impacts was a key consideration during the route selection process. As

outlined in section 3.3 of the environmental assessment, an environmental cost benefit analysis was also undertaken during the preferred route corridor selection process.

The specific environmental management measures required for the preferred route were refined following the identification of the successful route option. The need for offsets to minimise residual environmental impacts were identified following further refinement of the preferred route to reduce adverse environmental impacts.

- 3) The Proposal uses existing road reserves or publicly owned land where possible to minimise impacts on private property. The decision to open Wyndell Close to traffic was based on the need to develop a safe and efficient service road network linking the Proposal with the existing Pacific Highway and Cooperabung Drive.

The opening of Wyndell Close as part of the Proposal was included as part of the *Oxley Highway to Kempsey Access Strategy Report, October 2007*. This report was prepared following feedback from a number of consultation activities with the community throughout 2007. Those activities are detailed in section 1.5.1 of the strategy report and included a precinct committee meeting at Telegraph Point on 19 July 2007. The RTA also placed advertisements in the local newspapers between 12 and 16 October 2007 to advise the community that the strategy report had been placed on the project website.

2.2 Licensing

Submission numbers

136 - Department of Environment, Climate Change and Water (DECCW)
141 – NSW Office of Water (NOW)

Issue description

NOW and the DECCW made a number of comments regarding the environmental licences required for construction and operation of the Proposal.

- 1) NOW advised that licences would be required for:
 - Dewatering activities (under the *Water Act 1912* and the *Water Management Act 2000*).
 - Extraction of surface or groundwater for construction purposes.
 - Installation of groundwater monitoring bores.
 - Any works that intersect the water table.
 - Permanently changing the course of a stream or river.
- 2) NOW advised that there is currently an embargo on any further applications for subsurface water licences for *"Coastal Floodplain Alluvial Groundwater Sources and Highly Connected Alluvial Groundwater Sources of Coastal Catchments - Regional NSW"*. However NOW also advise that exemptions may be applicable during construction for industrial purposes with a limit placed on volume extracted.
- 3) NOW noted that the Proposal includes the construction of sediment basins and advised that all sediment basins must be constructed above the watertable and lined with impermeable material. They must also be constructed in accordance with the Farm Dams Policy and the Maximum Harvestable rights order under section 54 of the *Water Management Act 2000*.

- 4) DECCW advised that an Environment Protection Licence (EPL) would be required for the construction of the Proposal.

Response

- 1) The requirement for the project to obtain these licences has been noted. The licences, permits and approvals required for construction would be identified through the construction environmental management plan. All necessary licences, permits and approvals would be obtained.
- 2) The RTA notes the embargo on any further applications for subsurface water licences for "*Coastal Floodplain Alluvial Groundwater Sources and Highly Connected Alluvial Groundwater Sources of Coastal Catchments - Regional NSW*". The RTA may make application for exemptions should subsurface water licences be required.
- 3) Sediment basins would be designed and installed in accordance with *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom 2004) and *Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction* (DECC 2008b). The advice from NOW is noted, however the RTA considers it is exempt from the Farm Dams Policy and the Maximum Harvestable rights order under section 54 of the *Water Management Act 2000* as sediment basins are considered to be special dams exempted from licensing and calculation of use of harvestable rights.
- 4) The requirement for the project to obtain an EPL has been noted. The licences, permits and approvals required for construction would be identified through the construction environmental management plan. All necessary licences, permits and approvals would be obtained.

2.3 Project support

Submission numbers

28 – Individual
29 – Individual
38 – Individual
39 – Individual
40 – Individual
43 – Individual
44 – Individual
45 – Individual
46 - 134 – Form letters
136 – Department of Environment, Climate Change and Water (DECCW)
144 – 146 – Form letters

Issue description

- 1) 101 submissions community and government agency submissions expressed support for the Proposal. This included 92 form letters and one community submission that identified the current Sancrox Road and Pacific Highway intersection as being dangerous and hoped to see work commence very soon on the Proposal. Four business submissions also expressed support for the upgrade of the Sancrox Road area to improve access and safety. Three community submissions and the DECCW submission expressed conditional support for the Proposal.

- 2) One community submission commended the project team for the comprehensive environmental assessment and their attention to mitigating the environmental impacts of the upgrade of this section of the Pacific Highway Upgrade.
- 3) DECCW supported the Proposal, subject to proposed amendments to the draft statement of commitments being satisfactorily addressed and recommended conditions of approval being incorporated in the project approval.

Response

- 1) The support for the Proposal is acknowledged and appreciated.
- 2) The RTA is committed to providing comprehensive environmental assessments and appropriate mitigation measures to minimise any identified environmental impacts associated with the Proposal. The recognition of this effort is acknowledged and appreciated.
- 3) DECCW's support is noted. The recommendations have been considered and (where appropriate) incorporated in the revised statement of commitments (see Section 2.20 of this report). These recommendations will be further discussed with DECCW.

2.4 Community consultation

Submission numbers

4 – Individual
10 – Individual
11 – Individual
16 – Individual
19 – Individual
22 – Individual
29 – Individual
32 – Individual
34 – Individual
41 – Individual

Issue description

Ten community members made submissions regarding community consultation. Some submissions were concerned with the general consultation process, while others related specifically to consultation during the route selection, environmental assessment exhibition, and construction phases.

- 1) One community submission considered the time available to review the EA documentation prior to landowner meetings was inadequate.
- 2) Two community submissions raised concerns about the selection process for community representation on the Community Liaison Group.
- 3) One community submission raised concerns about the lack of consultation with the local Glen Ewan Road community.

- 4) Four community submissions acknowledged the professionalism, patience, transparency and commitment of the RTA project team including one community submission thanking the RTA for the opportunity to participate in the Community Liaison Group and Ecological Focus Group meetings.
- 5) One community submission requested another meeting with the RTA project team and another requested a copy of notes from the landowner meeting held during the staffed display.
- 6) One community submission advised that they were not told about a 2007 community meeting.

Response

- 1) The public exhibition period for the environmental assessment is set by the Department of Planning based on the statutory timeframe of at least 30 days as described under section 75H(3) of the EP&A Act. The actual exhibition period for the Project continued for 45 days (15 September to 29 October 2010), and submissions were accepted by the Department of Planning as late as 5 November 2010. The environmental assessment was made available to the community from the start of the display period via the project website and the Department of Planning website. Additionally an electronic copy of the environmental assessment was mailed to each of the directly impacted landowners along with a copy of the community update on 10 September 2010.

The landowner meetings were held during the first and fifth weeks of the display period to discuss the impacts of the proposal on their respective properties. The staffed displays and the landowner meetings also provided landowners with an opportunity to ask project team members questions about the environmental assessment and the Proposal.

The project team and display resources provided at the staffed display location during these meetings provided an opportunity for the landowners to view high quality mapping and design information.

- 2) The RTA requested nominations from the community to join a community liaison group for the Oxley Highway to Kempsey upgrade via invitations advertised in local newspapers and the community update in 2004. This community update was mailed to residents in, and adjacent to, the study area. An advertisement was also placed in local newspapers in November 2004 to inform the community of an information meeting and calling for nominations for the community liaison group. Approximately 12 representatives were selected. The RTA selected candidates that would allow for representation of a broad range of community groups and interests. The community liaison group was formed in December 2004 with representatives being selected from interested stakeholders at that time. The RTA has not discouraged additional representatives on this group throughout the development of the project.
- 3) Over the course of the project, a range of community and stakeholder involvement activities have been implemented. These are summarised in section 5 and table 5-2 of the environmental assessment. While not all stakeholders were consulted directly, community updates, website information and public exhibitions of the route options, preferred route and environmental assessment were made available to all members of the community and submissions invited.

Several meetings were held with landowners in the Glen Ewan Road area during the development of the preferred route and the environmental assessment.

- 4) The RTA is committed to providing a transparent process to allow community participation during the development of the preferred route and environmental assessment process. The recognition of this commitment is acknowledged and appreciated.
- 5) The RTA will continue to meet with directly affected and adjacent landowners as necessary and meeting notes can be provided on request. The RTA will continue to consult with directly affected and adjacent landowners throughout the detailed design and construction phase to ensure that any concerns are addressed and the process explained.
- 6) The RTA placed advertisements in the *Kempsey – Macleay Argus*, *Port Macquarie News* and the *Port Macquarie Express* during February 2007 advising a public meeting would be held at the Kundabung Hall on 1 March 2007 to discuss access arrangements for the Kundabung area. The RTA also placed advertisements in the local newspapers in October 2007 to advise the community that the *Oxley Highway to Kempsey Access Strategy Report* had been placed on the project website.

2.5 The Proposal

2.5.1 Design

Submission numbers

- 8 – Individual
- 10 – Individual
- 16 – Individual
- 18 – Individual
- 21 – Individual
- 36 – Individual
- 38 – Individual
- 40 – Individual
- 41 – Individual
- 138 – Kempsey Shire Council (KSC)

Issue description

- 1) One community submission requested that appropriate navigation markers or lights be installed on new Hastings River bridge.
- 2) One community submission requested that the clearance under the bridge across Hacks Ferry Road is sufficient to allow the movement of cattle trucks and other tall vehicles.
- 3) One community submission expressed concerns that the Proposal will block the current drainage line near station 16200.
- 4) One community submission expressed the need for intersections and service roads in the vicinity of Cooperabung Close to be designed to allow turning movements for heavy vehicles.
- 5) One community submission advised that the proposed concept design for the Yarrabee Road traffic arrangement will impact the operation of major events at the Hillclimb track.
- 6) KSC asked why a left in / left out is required at Smiths Creek Road which is in close proximity to the Kundabung interchange.

- 7) The submission from KSC sought additional information to demonstrate the link between Kempsey bypass currently under construction and the Oxley Highway to Stumpy Creek alignment.

Response

- 1) The bridges included in the Proposal for the Hastings and Wilson river crossings would include the navigation clearance required by the NSW Maritime (section 6.4.6 of environmental assessment). The type of navigation markers that would be installed on the bridges would be determined during the detailed design following consultation with NSW Maritime.
- 2) The typical features of the proposed bridge across Hacks Ferry Road and the Wilson River are described in table 6-6 of the environmental assessment and include a minimum clearance of 4.6 metres over Hacks Ferry Road, sufficient for most vehicles. The design of the bridge will be further refined during the detailed design phase and provision would be made to ensure access for larger farm and delivery vehicles is maintained to local properties.
- 3) Drainage and surface water flow provisions included in the concept design of the Proposal are outlined in section 6.4.15 of the environmental assessment. The design of the Proposal generally allows for the natural drainage and flow paths to be maintained across the Proposal using a combination of culverts and bridges. The concept design for the Proposal includes drainage culverts and flood relief structures across the Wilson River floodplain near station 16200. The details of the drainage culverts and flood relief structures will be further refined during the detailed design phase following detailed ground survey.
- 4) The design criteria for the service and access roads is discussed in section 6.4.5 of the environmental assessment. The existing level of access to all privately owned properties would be maintained throughout the construction and operation of the Proposal. There may however be refinements to existing access arrangements, which would be decided in consultation with property owners during the detailed design phase. The service and access road system would be designed to allow normal heavy vehicle movements. However B-double vehicle movement would be restricted to only those roads with current B-double access approval.
- 5) The potential impacts on the Hillclimb track were considered during the preparation of the environmental assessment and the concept design. However, we note the advice from the respondent regarding the potential impacts on the operation of larger events at the Hillclimb track. The RTA would investigate the potential to adjust the alignment of Yarrabee Road during the detailed design phase. Further consideration would be given to the level of impact on the track and the most suitable adjustment options and if applicable, negotiations undertaken in accordance with the requirements of the *Land Acquisition (Just Terms and Compensation) Act 1991*.
- 6) The left in / left out access at Smiths Creek Road forms part of the Kundabung Road and Rodeo Drive traffic arrangement. This left in / left out access provides access to and from the traffic arrangement for northbound traffic. Section 6.4.4 of the environmental assessment provides details of this traffic arrangement and figure 6-7 of the environmental assessment shows the full traffic arrangement.
- 7) The features of the Proposal are described in section 6.3 of the environmental assessment with the layout of the Proposal between the Maria River and the Kempsey bypass shown in figure 6-2q. While the exact location and height of the Proposal would be refined

during the detailed design, the following additional information is provided to assist in clarifying aspects of the Proposal between the Maria River and the Kempsey bypass.

- The main carriageways of the Proposal will join the Kempsey bypass project on the northern side of two new bridges to be constructed across Stumpy Creek.
- The southbound carriageway of the Proposal would generally be in a similar location to the southbound carriageway of the existing Pacific Highway.
- A new northbound carriageway would be constructed approximately 35 metres east of the current northbound carriageway (centre line to centre line) and adjacent to the southbound carriageway.
- The northbound carriageway of the existing Pacific highway would be converted to a two way service road connecting the old Maria River bridge to the South Kempsey interchange. This would include the section of old highway between the Maria River and the Scrubby Creek Road intersection.
- The Proposal would generally be at a similar level as the existing Pacific Highway near the existing Kamps Road intersection.
- The Proposal would be constructed to meet the appropriate road safety standards to prevent the interaction between traffic using the main highway carriageways and the service road users.

2.5.2 Handover

Submission numbers

I8 - Individual

I38 - Kempsey Shire Council (KSC)

Issue description

One community submission and the KSC submission asked about the ownership of the service roads and access roads described as part of the proposal. While KSC also asked for additional details about the handover package for the service and access roads.

Response

As a key element of the Proposal, new service and access roads would be constructed to connect with the existing local road network and private properties. Sections of the existing Pacific Highway left as a result of deviations would be retained for use as part of the service road network. Some of the existing local roads that would form part of the service road network may require upgrading, the extent of which would be determined during detailed design.

The RTA would negotiate the handover of any newly constructed service / access roads and bypassed sections of the existing highway with Port Macquarie Hastings Council and KSC during the detailed design and construction phases of the project. These negotiations would deal with issues such as the status of the roads to be handed over to council, any future funding issues associated with the handover and any works required as part of the handover process.

2.5.3 Interchanges and traffic arrangements

Submission numbers

- 1 – Individual
- 2 – Individual

Issue description

Two community submissions identified issues in relation to the proposed interchanges and traffic arrangements.

- 1) One community submission expressed concern over the proposed traffic arrangement at Sancrox Road / Fernbank Creek Road due to complexity and suggested that the overbridge be relocated so that it is in line with Sancrox / Fernbank Creek Roads.
- 2) One community submission suggested moving Blackmans Point interchange to a new location at Bill Hill Road and construct bridges for the Proposal to cross both the existing Pacific Highway and Blackmans Point Road.

Response

- 1) The design and location of the Sancrox Road / Fernbank Creek Road traffic arrangement was investigated during the development of the concept design for the Proposal following extensive consultation with the local community. Preliminary geotechnical, environmental, traffic, heritage and engineering investigations, identified three access options in the Sancrox area. Due to the level of impact of an overbridge at the location of the existing intersection, these options all consisted of an overbridge south of the Sancrox Road / Fernbank Creek road intersections, connecting the east and west sides of the highway via service roads. The current option was adopted as part of the *Oxley Highway to Kempsey Highway Access Strategy* published in 2007 following community feedback and further assessment of the environmental constraints and engineering requirements. The proposed traffic arrangement facilitates the proposed Sancrox Employment Precinct, as well as the residential development to the south-west known as Sovereign Hills. It also has the benefit of being suitable for early staged construction.

The relocation of the overbridge to align it with the existing Sancrox Road would significantly impact local landowners and businesses. Greater areas of land would be needed to construct the embankments required for the overbridge and associated on / off ramps on both sides of the Proposal, along with the other traffic management measures to ensure the safe movement of vehicles using the interchange. This would add significant cost to the construction of the Proposal through additional acquisition and impact management measures.

- 2) Several options for the Blackmans Point Road interchange were investigated during the development of the concept design for the Proposal. These options were reduced to three potential designs and locations for the interchange. The design, as displayed in the environmental assessment, was included as part of the concept design following preliminary geotechnical, environmental, traffic, heritage and engineering investigations and represents the best balance of environmental, engineering and social factors when compared with the alternatives. The concept design will be further refined during the detailed design phase following consideration of issues raised in submissions to the environmental assessment and detailed ground survey.

The relocation of the interchange to the Bill Hill Road overpass location would result in greater impacts on the Caimcross State Forest due to the need for the inclusion of on / off ramps and other traffic management measures to ensure the safe movement of vehicles at the interchange. The current location of the interchange is considered to best service the needs of the local population centres of Telegraph Point and Port Macquarie.

2.5.3.1 Service road access

Submission numbers

2 – Individual
6 – Individual
8 – Individual
10 – Individual
12 – Individual
13 – Individual
14 – Individual
15 – Individual
19 – Individual
21 – Individual
22 – Individual
24 – Individual
25 – Individual
27 – Individual
30 – Individual
36 – Individual
37 – Individual
45 – Individual
138 – Kempsey Shire Council (KSC)
142 – Individual
143 – Individual (Confidential)

Issue description

- 1) One community submission requested that the service road be an all weather sealed road and be constructed to provide for the turning of heavy vehicles.
- 2) Confirmation was sought from one community submission as to whether the proposed overbridges would be constructed to accommodate heavy vehicles (B-double trucks).
- 3) One community submission requested that a "no through road" sign be placed at the entrance to Wharf Road to prevent illegal dumping of rubbish in Caimcross State Forest, deterioration of Wharf Road and trespassing on private property.
- 4) One community submission questioned why Bill Hill Road is to be upgraded and suggested that Hatch Road be upgraded instead as it would be a cheaper option.
- 5) One community submission expressed concerns that Hacks Ferry Road needs to remain open and be maintained during the construction period to allow access to properties.
- 6) Concern was raised by one community submission over the use of the existing highway by heavy vehicles through Telegraph Point to access Caimcross Waste Management Facility and suggested that an interchange be constructed at Bill Hill Road to allow direct access to the facility for waste vehicles from the north of Telegraph Point.

- 7) Two community submissions objected to the opening Wyndell Close to traffic due to increased traffic noise and impacts on amenity, property access, safety, stormwater drainage, air quality, recreation activities and business operations.
- 8) One community submission is concerned about the cost of the construction and maintenance of the proposed Mingaletta Road overbridge and service road and provided an alternative intersection arrangement.
- 9) Two community submissions objected to the construction of the Kundabung Road overbridge due to potential property and lifestyle impacts.
- 10) Concern was raised by a community submission about the increase in traffic along the proposed service road along Rodeo Drive.
- 11) Two community submissions suggested that the traffic volumes contained in the environmental assessment for Rodeo Drive / Ravenswood Road area and Wharf Road (near Hastings River) are under estimated.
- 12) Thirteen community submissions raised concerns over the opening of Rodeo Drive as a service road and requested relocating the service road to the eastern side of the main highway.
- 13) Claims were made by two community submissions that they were told by RTA that Rodeo Drive would remain a no through road.
- 14) One community submission questioned whether the service road on the western side of Property 83 will be a sealed road.
- 15) One community submission questioned if the existing access to Scrubby Creek Road to the Proposal would be retained.

Response

- 1) The general description of the proposed new service roads and access roads is provided in section 6.4.5 of the environmental assessment with design criteria for these roads provided in table 6-4 service road and access road design criteria. It is generally expected that all new service and access roads would be sealed roads, which would be designed and constructed to meet the requirements of the local council for the existing local traffic usage.
- 2) All existing B-double truck accesses would be maintained as part of the Proposal. The overbridges included in the Proposal would be designed to accommodate B-double truck movements.
- 3) The signposting of local roads would continue to be the responsibility of the relevant local council. Any decision to erect a "no through road" sign at Wharf Road would be a decision for Port Macquarie Hastings Council.
- 4) The decision to upgrade Bill Hill Road was based on a number of environmental, social and engineering issues. Bill Hill Road re-instates access to Cairncross State Forest as well as adjacent private properties to the existing Pacific Highway and the Proposal. The upgrade of Hatch Road falls outside the scope of the Proposal and any decision to upgrade this road would rest with Port Macquarie Hastings Council.

- 5) The RTA would ensure that access is maintained along Hacks Ferry Road during construction.
- 6) As discussed in section 6.3.2 of the environmental assessment, the Proposal involves a bypass of Telegraph Point with the existing Pacific Highway retained as a service road between the Blackmans Point Road interchange and the Haydons Wharf Road half interchange. The amenity of the Telegraph Point village and other landowners in close proximity to the existing highway in this area would be significantly improved due to the reduced traffic volumes. The vehicles accessing the Cairncross Waste Management Facility from the north would have the option of using either the main carriageways of the Proposal for as long as possible and accessing the facility via the Blackmans Point interchange, or utilising the service road through Telegraph Point via the Haydons Wharf half interchange. Given the better alignment and proposed speed zoning of the Proposal, it would be expected that most heavy vehicles wanting to access this facility would take advantage of the more direct highway option rather than exiting onto an indirect local road option. Further to that, the RTA considers the upgrading of the Bill Hill Road overbridge to an interchange is not feasible due to the additional ecological impacts on the Cairncross State Forest and the additional cost.
- 7) The Proposal has been developed to improve the safety of road users through the separation of highway and local traffic. To help achieve this improved safety it is necessary to rationalise and restrict the at grade access to the upgraded highway through the proposed service and access road network linked to the interchanges and traffic arrangements. One of the changes required to the local road network to maintain the functionality of the service road network is the opening of Wyndell Close. This allows residents in the area around the northern end of Cooperabung Close access to the Haydons Wharf Road half interchange as well as the existing Pacific Highway which is to be retained as a service road to access Port Macquarie.

While the RTA acknowledges that the proposed opening of Wyndell Close would result in some changes for property owners along Wyndell Close it considers it necessary that Wyndell Close be opened to maintain local connectivity and safe access to the Proposal for local residents.

- 8) The Proposal objectives are stated in section 3.2 of the environmental assessment while the design objectives for the Proposal are summarised in table 6-2. These objectives are consistent with the objectives of the Pacific Highway Upgrade Program and other Pacific Highway projects and have been developed to ensure the Proposal improves safety for road users and improves the efficiency of the highway. A key Proposal and design objective is to restrict direct highway access to only interchanges and traffic arrangements and reduce the chances for highway traffic to interact with lower speed local traffic. The proposed overbridge at Mingaletta Road is considered to be a cost effective solution to meet the Proposal and design objectives. The suggested at grade intersection for Mingaletta Road does not meet the objectives of the Proposal.

As discussed in section 6.3.3 of the environmental assessment the Mingaletta Road overbridge would not be constructed as part of the arterial standard stage. During this stage the existing at grade intersection would be altered to improve the safety of the intersection.

The maintenance of the overbridges included as part of the Proposal would be carried out by the RTA while the maintenance of the service roads and local roads would be carried out by the local council. The RTA would negotiate the handover to local councils of any new service and access roads, as well as the existing highway where it becomes part of the proposed service road network. Service roads would generally be constructed to an all

weather standard.

- 9) The Kundabung Road overbridge forms an integral part of the Kundabung Road and Rodeo Drive traffic arrangement and it is not proposed to remove the overbridge from the Proposal. The overbridge provides a safer connection for local Kundabung residents currently separated from local services such as the post office and service station by the existing Pacific Highway. The traffic arrangement provides controlled access to and from the Proposal for both north and south bound motorists. The property and lifestyle impacts of the overbridge have been considered in chapters 10, 11, 16 and 17 of the environmental assessment. Mitigation measures have been identified to minimise property and lifestyle impacts and would include property acquisition, landscaping and architectural treatment.
- 10) The RTA acknowledges that the proposed opening of Rodeo Drive would result in some changes for property owners and an increase in traffic volumes. However it is necessary that Rodeo Drive be opened to maintain local connectivity and safe access to the Proposal for local residents.

The predicted traffic volumes presented in section 18.3.3 of the environmental assessment are based on observed traffic counts at intersections including Smiths Creek Road, Mingaletta Road and Kundabung Road. The traffic volumes were then adjusted taking into account existing and proposed land use and the proposed changes to the service road network. This included additional local heavy vehicles that could use the service roads such as logging trucks and buses.

The Proposal has been developed to improve the safety of local road and highway users through the separation of highway and local traffic. To help achieve this improved safety it is necessary to rationalise and restrict direct access to the upgraded highway through the proposed service and access road network linked to the interchanges and traffic arrangements.

Under the arterial standard stage of the Proposal sections of Rodeo Drive and Ravenswood Road would be linked to provide residents in the Kundabung area with safer access to local facilities as well as the upgraded highway. The extension of the connection of Rodeo Drive with the remainder of the service road network south of Smiths Creek would occur as part of the final motorway standard.

- 11) The predicted traffic volumes presented in section 18.3.3 of the environmental assessment are based on observed traffic counts at intersections including Smiths Creek Road, Mingaletta Road and Kundabung Road. The traffic volumes were then adjusted taking into account existing and proposed land use and the proposed changes to the service road network. This included additional local heavy vehicles that could use the service roads such as logging trucks and buses.

Where traffic counts were not available, the traffic volumes were estimated from first principles utilising the RTA's *Guide to Traffic Generating Developments* to estimate the traffic data from a traffic catchment.

- 12) The Proposal as described in chapter 6 of the environmental assessment includes a network of service and access roads. This network has been developed to help meet the Proposal objectives outlined in section 3.2 of the environmental assessment. As part of the development of the service and access road network for the Proposal, the RTA also considered the needs for local community members to maintain access to local facilities as well as the need to access the main highway for travel to major centres north and south of the Proposal.

The Project team considered several options for providing a continuous alternative service road network during the development of the Proposal. In the Rodeo Drive area both eastern and western service road options were considered. However the eastern option was considered not to be feasible as the service road would not fit within the existing road corridor and would result in additional property acquisition and agricultural impacts. The connections required to overbridges and traffic arrangements to maintain the functionality and connectivity of the eastern option were complex. Using the existing sections of Rodeo Drive and Ravenswood Road in the Kundabung area takes advantage of existing public road corridors, improves connectivity between Rodeo Drive and Ravenswood Road, minimises property acquisition and provides best value for money for the Proposal.

Rodeo Drive was identified as a proposed service road in the *Preferred Route Option Report* announced on 28 August 2006 and displayed until 13 October 2006. The use of Rodeo Drive as a service road was also described in more detail in the *Oxley Highway to Kempsey Highway Access Strategy* published by the RTA in October 2007.

The RTA acknowledges that there would be an increase in local traffic using this section of Rodeo Drive when it is opened as part of the proposed service road network. However, the Proposal has been developed to improve the overall safety of both local road and highway users through the separation of highway and local traffic. The concept design for the Proposal includes facilities to minimise the need to divert highway traffic onto the service roads following accidents. Should one carriageway of the upgrade be closed due to an accident, emergency crossover facilities would enable vehicles to be diverted onto the adjacent carriageway.

- 13) The deviation of the existing highway to the east of Rodeo Drive in 1986 created several remnant sections of unused "old" highway that became local roads to ensure access was maintained to the Pacific Highway for properties that previously fronted the "old" highway. This included a no-through road at the southern end of Rodeo Drive. Since this time the need for an upgraded highway between Port Macquarie and Kempsey has been identified. The RTA identified that a re-opened Rodeo Drive would form part of the Proposal as a service road in the *Preferred Route Option Report* in 2006. Using Rodeo Drive as a service road takes advantage of existing public road corridor, improves connectivity between Rodeo Drive and Ravenswood Road, minimises property acquisition and provides best value for money for the Proposal. The RTA is unable to verify the statement made regarding Rodeo Drive remaining a no through road.
- 14) It is envisaged that the new access road proposed along the western side of Property number 83 would be a sealed road built to meet the criteria identified in section 6.4.5 of the environmental assessment, but this would be determined in consultation with Council.
- 15) The northern access to Scrubby Creek Road falls within the Kempsey bypass project and will not be impacted by the Proposal. The southern access to Scrubby Creek Road would intersect with the western service road just to the north of the Maria River. Access from Scrubby Creek Road to the service road would be reinstated at this location. Access to and from the upgraded highway from Scrubby Creek Road would be available via the western service road and the South Kempsey interchange.

2.6 Construction of the Proposal

2.6.1 Staging

Submission numbers

5 – Individual
31 – Individual

Issue description

Three community submissions raised issues with regard to the construction of the Proposal.

- 1) Two community submissions identified that the M class (motorway standard) would be safer than the A class (arterial standard) option.
- 2) One community submission sought advice on the timing for the construction of the Proposal.

Response

- 1) The observations regarding the safety of the options are noted. The RTA is required to ensure the best use of available funds on any given project and considers that the proposed arterial standard staging option for Sections C and D of the Proposal would improve road safety and reduce accidents for these sections when compared to the existing highway. The proposed staging option would also provide the capability for these sections to be upgraded to the motorway standard when the need arises. The proposed arterial standard includes the rationalisation of accesses to the highway and separation of carriageways. The ultimate motorway standard dual carriageway upgrade is expected to further improve road safety and reduce accidents when compared to the existing highway and the arterial standard option due to the separation of local and through traffic and grade separated access to the highway.
- 2) The expected timing for the start of construction of the Proposal would depend upon several factors including approval of the Proposal by the Minister for Planning (DoP), the availability of funding and the priority for upgrading as part of the Pacific Highway Upgrade Program.

As discussed in section 7.4.1 of the environmental assessment, the period of construction could range from three to five years, however this would be dependent on funding, staging options and construction delivery methods adopted. A recent announcement was made by the Australian Government of \$35 million to prepare the project for construction. This includes property acquisition, detailed geotechnical investigations and detailed survey in preparation for construction of the Proposal should project approval be granted by DoP.

2.6.2 Construction management

Submission numbers

16 – Individual
22 – Individual

Issue description

Two community submissions raised issues regarding construction management.

- 1) One community submission expressed concern about noise from construction compounds and does not wish to have a compound located near their property.
- 2) One community submission expressed concern about the safety of road users and residents interacting with construction traffic entering and exiting Glen Ewan Road.

Response

- 1) The location of ancillary facilities, such as construction compounds, is discussed in section 7.6.7 of the environmental assessment. The specific location of these facilities would be confirmed during the detailed design phase in consultation with the construction contractor and would be dependant upon the selected delivery method and construction staging option adopted. The site selection criteria for potential ancillary facilities are outlined in table 7-6 of the environmental assessment. The minimum preferred distance to a construction site compound from a residence would be 200 metres. Also the management of noise generated by such facilities would be subject to the relevant construction noise conditions of approval, the Environmental Protection Licence for construction, and would be addressed in the construction noise management plan as part of the Contractor's Construction Environmental Management Plan.
- 2) Construction phase traffic impacts on local roads, including Glen Ewan Road, would be managed through a Construction Traffic Management Plan, which would be prepared in consultation with the community and local councils. This plan would be implemented by the construction contractor to ensure the safe and efficient movement of construction traffic while minimising impacts on local traffic and inconvenience to local residents. Local residents and council officers would be consulted and advised of any temporary traffic diversions or changes to existing access routes needed during the construction period. These traffic diversions would also be advertised in local media prior to the changes being made and identified on site by the use of clear sign posting.

2.7 Land use and property

2.7.1 Property acquisition and compensation

Submission numbers

3 – Individual
6 – Individual
8 – Individual
10 – Individual
11 – Individual
15 – Individual
20 – Individual
22 – Individual
30 – Individual
38 – Individual
39 – Individual
40 – Individual
146 – Forests NSW

Issue description

Submissions from twelve community members raised issues in relation to property acquisition.

- 1) Seven community submissions expressed concerns about the amount of compensation that will be made by the RTA. Specific concerns included:

- The need to consider improvements to the land and cropping potential when determining the level of compensation for the acquisition of agricultural properties.
 - The need to consider the loss of value of property and home, as well as any loss of land and vegetation when determining the level of compensation for the acquisition of properties.
 - Advice that the Proposal will affect two separate titles on a property.
 - Several requests for the RTA to totally acquire several properties instead of part of the properties.
- 2) One community submission requested written assurances that the RTA would repair damages resulting from flooding through viaducts at no cost to the owner and purchase the property should the groundwater table be changed.
 - 3) One community submission wished to discuss alternative compensation for impacts on the Hillclimb Track.
 - 4) Two community submissions and one business owner expressed concerns about the amount of land to be acquired from their respective properties.
 - 5) The submission from Forests NSW raised the need for compensatory land via a land exchange to mitigate against the impact on state forests from the Proposal.

Response

- 1) Property acquisition and negotiations would be undertaken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. The aims of the Act include '*to guarantee that, when land affected by a Proposal for acquisition by an authority of the State is eventually acquired, the amount of compensation would be not less than the market value of the land (unaffected by the Proposal) at the date of acquisition*'. Factors such as existing land use, building assets and other improvements are taken into consideration in the valuation process.

While the preference of a total acquisition from some property owners is noted, the RTA would only acquire land required for the proposed roadworks. All total acquisitions must be justified. In some cases, the RTA may only seek to purchase part of the property. All land acquisitions would be subject to discussions and negotiation with the individual landowner.

- 2) As outlined in section 12.3.3 of the environmental assessment, changes in the flooding behaviour of the Wilson River as a result of the Proposal are predicted to include a small increase in flood levels upstream of the upgraded highway. The RTA is committed to implementing those management measures identified in the environmental assessment and does not believe there would be any detrimental impact on the subject property as a result of flooding. No written assurances are provided by the RTA. Civil action is available to the landowner in the event of an issue arising.

Potential impacts on groundwater have been discussed in section 14.3 of the environmental assessment. Further investigations and groundwater modelling of the Wilson River floodplain is proposed during the detailed design phase to define the impacts of the Proposal on groundwater in the area. Should impacts be identified, nearby landowners would be consulted and suitable management measures considered at that time. Any adverse impacts identified which can not be mitigated would be considered when assessing compensation under the RTA Land Acquisition Policy and the *Land Acquisition (Just Terms Compensation) Act 1991*.

- 3) The RTA confirms that the most suitable property adjustment options would be considered following the preparation of the detailed design, and if applicable, negotiations undertaken in accordance with the requirements of the *Land Acquisition (Just Terms and Compensation) Act 1991*.
- 4) The Proposal has been designed to minimise the acquisition of private property. In most cases the RTA has attempted to acquire land with no known property improvements. Those landowners affected by land acquisition would be consulted to discuss appropriate compensation in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the RTA Land Acquisition Policy.
- 5) As outlined in section 10.2 of the environmental assessment, approximately 114 hectares of state forest would be acquired for the Proposal. Acquisition of state forest land would occur following an Act of Parliament, resolution of Parliament, or notice in the Government Gazette. However, an option available to the RTA and Forests NSW could include a land exchange. A land exchange could be appropriate where suitable land is available from other RTA projects in the case where land holdings exceed requirements. The RTA would undertake negotiations with Forests NSW to determine the suitability of a land exchange.

2.7.2 Property infrastructure

Submission numbers

- 4 – Individual
- 9 – Individual
- 21 – Individual
- 22 – Individual
- 28 – Individual
- 35 – Individual
- 42 – Individual
- 43 – Individual
- 137 – Industry and Investment NSW (I&I NSW)

Issue description

Seventeen community submissions, as well as a submission from I&I NSW, raised issues in relation to property infrastructure.

- 1) Seven submissions, including six community submissions and a submission from I&I NSW, expressed concerns over the impact of the Proposal on water supply and fencing infrastructure and the need for either compensation or to make alternative arrangements.
- 2) Four submissions, including three community submissions and a submission from I&I NSW, expressed concern about stock movement and access to flood protection facilities (mounds, high ground).
- 3) Three community submissions expressed concern over access to and within properties during construction and following the completion of the Proposal, requesting property access be re-instated.
- 4) Two community submissions questioned whether powerlines would need relocating and whether notice and assistance would be given to maintain power supply.

- 5) One community submission expressed concern over the proposed location of the revised access for the property as it would result in the need to create a right of carriageway through a busy work area adjacent to new workshop and suggested an alternative access.

Response

- 1) The replacement of existing property infrastructure, including fencing and water supply infrastructure (including both licensed water supplies as well as water supplies not requiring licenses), directly affected by the Proposal would be subject to negotiation with individual landowners as part of the property acquisition process during the detailed design phase of the project. Existing fencing impacted by the Proposal would be replaced with suitable fencing as part of the project at the RTA's cost. However, the replacement of fencing in other areas of a property not affected by the Proposal would normally not be considered.

- 2) As outlined in section 12.3 of the environmental assessment, changes in the flooding behaviour of the Hastings and Wilson rivers as a result of the Proposal are predicted to be minor due to the incorporation of mitigation measures in the concept design. It is anticipated that there would be minor increases in flood levels upstream of the Proposal on both floodplains and increases of less than two hours in the duration of flooding for a 1 in 100 year event.

The RTA is committed to reinstating emergency and stock evacuation routes to high ground or refuge areas affected by the Proposal and predicted changes to flood characteristics. The type of flood mitigation measures for individual properties impacted by the Proposal would be determined, designed and implemented in close consultation with landowners. All affected landowners would continue to be consulted during the detailed design and construction phases of the project.

- 3) As discussed in section 10.3 of the environmental assessment, the RTA is committed to maintaining access to, and within, properties during the construction of the Proposal. The construction contractor would consult with individual landowners should temporary changes to property access be required. All affected landowners would continue to be consulted during the detailed design and construction phases of the project to identify impacts on property access and management. The final package of management measures to reduce the operational impacts on the properties would be developed in consultation with the individual landowners.
- 4) The construction of the Proposal would require the relocation of some electricity and telecommunications cables as well as some water mains. The relocation of these utilities may result in interruption to services for some property owners. The adjustments to these utilities would be carried out by the relevant utility authority. These authorities would give property owners adequate notice prior to interruptions to power, telecommunications and water supplies.
- 5) The RTA notes the advice from the business operator regarding the potential to impact the operation of the existing business as result of the proposed property access. The location of the proposed property access for the property would be reviewed during the detailed design phase in consultation with the landowner.

2.7.3 Property values

Submission numbers

15 – Individual
20 – Individual
22 – Individual
32 – Individual

Issue description

Five community submissions raised the issue of property value impacts as a result of the Proposal.

- 1) Four community submissions raised concerns about property values as a result of the Proposal.
- 2) One community submission raised concerns about the inability to sell a property adjacent to the Proposal since the announcement of the preferred route.

Response

- 1) The Proposal is considered to achieve the best balance between environmental, social, engineering and economic constraints and opportunities when compared with the alternatives. The views of the respondents in relation to the effects on property values are noted, however there are many influences on property value and it is not agreed that the proposed works in themselves would necessarily devalue private property. The impacts on land use and planning, social and economic effects have been considered in chapters 10 and 11 of the environmental assessment.

Those landowners affected by land acquisition would be consulted and appropriate compensation negotiated in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the RTA Land Acquisition Policy.

- 2) The RTA acknowledges that properties affected by the Proposal may have been difficult to market throughout the preferred route and environmental assessment phases of the project due to uncertainty of likely environmental impacts. However the environmental assessment clarifies the likely environmental impacts of the Proposal providing greater certainty for potential purchasers.

2.7.4 Land use

Submission numbers

4 – Individual
24 – Individual
43 – Individual
138 – Kempsey Shire Council (KSC)

Issue description

- 1) Three community submissions expressed concerns that property acquisition will impact future development plans.

- 2) One business operator provided additional information on operations and traffic movements for the business.
- 3) The submission from KSC noted that the Mid North Coast Regional Strategy identifies the area between Port Macquarie and Kempsey as having potential to support employment lands, however KSC consider this issue is not adequately addressed in the documentation in relation to Kempsey.

Response

- 1) The Proposal is considered to achieve the best balance between environmental, social, engineering and economic constraints and opportunities when compared with the alternatives. This issue would be addressed as part of the property acquisition process carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.
- 2) The information provided on the operations and traffic movements for the business has been noted and would be used as background information during the construction phase of the project.
- 3) Section 10.2 of the environmental assessment considered the provisions of the Mid North Coast Regional Strategy. The only employment land identified within the Proposal area is located at Sancrox Road in the Port Macquarie-Hastings local government area. The employment land identified at South Kempsey is located outside of the Proposal area. However each of these areas would benefit from the Proposal and local road improvements. The Proposal would therefore facilitate the implementation of the strategy and would promote greater transport efficiency and safety for both intra and inter regional movements.

2.8 Social and economic

2.8.1 Agricultural impacts

Submission numbers

4 – Individual
9 – Individual
23 – Individual
137 – Industry and Investment NSW (I&I NSW)

Issue description

- 1) Three community submissions expressed concerns about the loss of income as a result of reduced stock carrying capability and subsequent reduction in the viability of the property.
- 2) The submission from I&I NSW noted that property and agricultural issues were considered during the development of the preferred route and the environmental assessment.
- 3) The submission from I&I NSW noted that the environmental assessment identifies a poultry farm adjacent to the northern end of the Proposal but does not provide details of the location of the farm or the potential impacts on the farm.

Response

- 1) The potential impacts on agricultural land use are outlined in section 11.2.2 of the environmental assessment. While a quantitative survey of agricultural properties was not undertaken, affected landowners were consulted during the route selection and concept design phases to determine the impacts on agricultural operations.

While the Proposal impacts several large agricultural operations, the overall viability and operational capacity of agricultural businesses would generally not be detrimentally affected.

The alignment has been established to minimise land take wherever possible. Where parcels of land are created with no access, in most cases these would be disposed of by either public auction or public tender, allowing them to be absorbed into adjoining agricultural land uses.

As discussed in section 11.3 of the environmental assessment, property owners would be compensated for land acquired from their properties. Any loss of productive land would be taken into account during property acquisition negotiations between the landholder and the RTA which would be carried out in accordance with the RTA's *Land Acquisitions Policy Statement* and the *Land Acquisition (Just Terms Compensation) Act 1991*.

During negotiations with property owners, consideration would also be given to compensation for the impacts on the facilities on properties (such as fencing, houses and buildings) and the acquisition of any severed or isolated sections of land where access cannot be reasonably reinstated to that section. Property adjustments would be negotiated with landowners to mitigate against the impacts on the operation of businesses/enterprises.

- 2) The advice from I&I NSW is noted.
- 3) Enquiries by the RTA following the display of the environmental assessment have revealed that the poultry farm identified in the environmental assessment is no longer operating.

2.8.2 Business impacts

Submission numbers

3 – Individual
9 – Individual
10 – Individual
14 – Individual
18 – Individual
23 – Individual
30 – Individual
39 – Individual
40 – Individual
43 – Individual
137 – Industry and Investment NSW (I&I NSW)
138 – Kempsey Shire Council (KSC)
142 – Individual

Issue description

- 1) Seven submissions, including six from business owners and one from KSC, expressed concerns about maintaining access to businesses during the construction phase.

- 2) Four submissions, including three community submissions and a submission from KSC, have sought additional information in relation to signage.
- 3) Four business owner submissions raised concerns about the potential for the Proposal to impact upon their business operations and loss of earning capacity with one business operator requesting compensation for loss of direct access to the highway.
- 4) Two landowners advised that existing advertising signage and the associated power supply would need to be relocated.
- 5) One community submission questioned whether a low level bridge on the access road over Pipers Creek will limit access to the business.
- 6) I&I NSW advised that the environmental assessment adequately addresses issues of interest to the Mineral Resources Division.

Response

- 1) As stated in section 10.3.2 of the environmental assessment, the RTA would ensure that where any legal property access is temporarily or permanently affected by the Proposal, alternative access to an equivalent standard would be provided where feasible or other alternative arrangements agreed in consultation with the business owner.
- 2) The RTA would consult with Port Macquarie Hastings and Kempsey Shire councils regarding the provision of appropriate signage on the highway and local roads. Signage would focus on key destinations or localities and signposting arrangements would be consistent with the RTA's signposting policy and signposting along the Pacific Highway generally. Members of the community would be able to provide input to the design and location of highway signage through a community information group which would be established during the construction phase.

The entry statement for Kempsey has been addressed previously as part of the Kempsey to Eungai Pacific Highway upgrade project to the north of the Proposal.

- 3) The potential impacts on local businesses have been discussed in section 11.2.4 of the environmental assessment with the measures proposed to mitigate those impacts discussed in section 11.3 of the environmental assessment. Directly affected business owners would be consulted throughout the detailed design and construction phases to ensure the Proposal minimises impacts on business operations. Negotiations will be undertaken with those business owners in regards to alternative access arrangements. Where part of the property is to be acquired, the acquisition of land will be in accordance with the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991*.
- 4) The RTA notes the advice from the landowners regarding the impacts on the signage and associated power supply. Negotiations will be undertaken with the relevant landowners in regard to compensation for infrastructure impacted by the Proposal.
- 5) The bridges crossing creeks on the proposed service and access roads, including the Pipers Creek crossing, are designed for a 1 in 100 year flood immunity. As discussed in the section 11.3 of the environmental assessment, should the access to the business be affected by the Proposal the RTA would consult with the owner to ensure an equivalent alternative legal access is provided.

The hydraulic modelling of Pipers Creek discussed in section 12.3.6 of the environmental assessment indicates that there would be no change in the flooding levels downstream of the bridges where the business is located.

- 6) The advice from I&I NSW is noted.

2.8.3 Local community impacts

Submission numbers

- 1 – Individual
- 2 – Individual
- 7 – Individual
- 10 – Individual
- 15 – Individual
- 17 – Individual
- 19 – Individual
- 22 – Individual
- 30 – Individual
- 31 – Individual
- 42 – Individual
- 143 – Individual (Confidential)

Issue description

- 1) Eleven community submissions raised concerns about impacts on amenity and privacy as a result of the Proposal during construction and once operational.
- 2) Three community submissions expressed concerns the Proposal will increase stress and adversely impact their health and well-being.
- 3) One community submission expressed concerns that the number of interchanges in the Proposal would result in the Proposal forming a barrier between the eastern and western sides of the highway and reduce the potential for development in this area.
- 4) One community submission sought advice regarding consideration of the location of the Hastings State Emergency Services (SWS) Community Driver Reviver Centre in relation to the Proposal.
- 5) One community submission questioned whether the increased litter from the upgrade, already a concern, will be screened and prevented from entering private property and Barrys Creek.

Response

- 1) The RTA acknowledges that the construction and operation of the Proposal could impact the local amenity of some properties in terms of visual, noise and air quality. Impacts on residential amenity have been addressed in the relevant sections of the environmental assessment and in other sections of this submissions report. Mitigation measures would be implemented during the construction of the Proposal to address identified visual, noise and air quality impacts. These measures or processes would be detailed in the Construction Environmental Management Plan (CEMP) prepared by the contractor prior to construction commencing. The environmental assessment incorporates management measures to address visual and noise impacts that may occur during the operation of the Proposal.

- 2) The RTA acknowledges the Proposal may increase the stress for some directly affected and adjacent landowners. The environmental assessment discusses the potential impacts on communities and individual properties. Section 11 of the environmental assessment provides an assessment of the potential socio-economic impacts of the Proposal and identifies appropriate management measures to minimise impacts on landowners. The RTA will continue to consult with directly affected and adjacent landowners throughout the detailed design and construction phase to ensure that any concerns are addressed and the process explained.
- 3) The preferred route, including sub-options, for the Oxley Highway to Kempsey Pacific Highway upgrade was announced in August 2006. The Preferred Route Option Report (NSW Roads and Traffic Authority, 2006) outlined potential locations of interchanges and traffic arrangements along the alignment. The locations of the interchanges and traffic arrangements were confirmed in the *Oxley Highway to Kempsey Highway Access Strategy* published by the RTA in October 2007. They have been located to improve connectivity in accordance with Proposal objectives, regional traffic needs and provide efficient access to the local road network and major regional centres in the study area. The interchanges and traffic arrangements connect with an enhanced service and access road network that uses sections of the existing highway, existing local roads and new service and access roads. This road network would provide a safe and efficient road system for the future development of the area.

As discussed in section 22.1 of the environmental assessment, the Proposal is likely to have economic benefits for the local and regional economy due to improved safety, travel efficiencies and removal of highway traffic from urban areas. These improvements to the broader community could help to stimulate the local economy in the longer term and therefore offer positive benefits to local landowners.

- 4) The Hastings SES Community Driver Reviver Centre was considered during the development of the concept design for the project. Highway travellers (both north and southbound) would be able to access the driver reviver centre via the Sancrox Road and Fernbank Creek Road traffic arrangement. Access for southbound highway travellers would be basically the same as the existing situation. The access to the centre for northbound highway travellers would be less direct, but much safer than the existing access arrangements as the right turn movements across southbound highway traffic will no longer occur.
- 5) Waste, including roadside litter, as a result of the operation of the Proposal has been addressed in section 20.5.1 of the environmental assessment. It is recognised that road users would generate litter along the highway and at rest areas. Containers for litter and other wastes would be provided at the rest areas, with contents to be disposed of at a suitable waste disposal station on a regular basis. The operational management of the Proposal, including waste management, would be administered via an operational environmental management plan. The Proposal would also offer less random stopping situations and therefore fewer opportunities for the dumping of rubbish.

2.8.4 Safety

Submission numbers

2 – Individual
5 – Individual
6 – Individual
14 – Individual
15 – Individual
22 – Individual
30 – Individual

Issue description

- 1) One community submission suggests that the Blackmans Point Road interchange provides no efficiencies in personal safety.
- 2) One community submission was concerned that opening Wyndell Close would reduce safety for road users.
- 3) The safety of exiting Cooperabung Close under the Class A (arterial standard) option was raised by one community submission.
- 4) Four community submissions expressed concern about the safety of pets and children along Rodeo Drive as a result of the Proposal.

Response

- 1) The Blackmans Point Road interchange includes measures to improve the safety for both local and highway traffic. The interchange includes deceleration and acceleration lanes to allow traffic to enter and exit the Proposal safely as well as traffic calming devices (eg: round-a-bouts) in areas where traffic movements occur. The arrangement also removes the need for right turn movements across high speed highway traffic currently required when leaving and entering the existing Pacific Highway to access Port Macquarie, Blackmans Point, the waste facility and other local roads.
- 2) As discussed in section 6.3.2 and 6.4.3 of the environmental assessment, Wyndell Close is an integral part of the service road network in the Telegraph Point and the Haydons Wharf Road half interchange areas. The RTA acknowledges that the proposed opening of Wyndell Close would result in an increase in traffic. However Wyndell Close would be upgraded to meet the design criteria discussed in section 6.4.5 of the environmental assessment. The criteria are considered appropriate to provide a safe environment for all road users including vehicle operators, local residents, cyclists and pedestrians. The local community and the relevant local council would be consulted prior to adopting a speed limit for the service roads.
- 3) The RTA acknowledges that the motorway standard option provides a safer option for accessing the upgraded highway by Cooperabung Close residents than the arterial standard option. However the arterial standard staging option would provide safer access to the upgraded highway than the existing highway. The arterial standard option includes measures to ensure the safety of vehicles entering and exiting the upgraded highway from Cooperabung Close such as deceleration and acceleration lanes into and out of Cooperabung Close along with a half interchange at Haydons Wharf Road and full interchange at Yarrabee Road.

- 4) Section 18.3.3 of the environmental assessment examines traffic and transport impacts of the Proposal on the service road network. It is acknowledged that there would be an increase in traffic using some of the service roads. This includes the Rodeo Drive and Ravenswood Road sections of the western service road. However these new service roads would be constructed to meet the objectives and design criteria discussed in section 6.4.5 of the environmental assessment. The criteria adopted are considered appropriate to provide a safe environment for all road users including vehicle operators, local residents, cyclists and pedestrians. The local community and the relevant local council would be consulted prior to adopting a speed limit for the service roads.

The concept design for the main carriageways of the Proposal includes measures to allow the switching of traffic should an incident occur on the highway that results in the closure of one carriageway. This will reduce the likelihood of increased traffic on the service roads when incidents occur.

2.9 Hydrology

2.9.1 Changes to existing flooding regime

Submission numbers

- 3 – Individual
- 4 – Individual
- 5 – Individual
- 6 – Individual
- 8 – Individual
- 11 – Individual
- 16 – Individual
- 27 – Individual
- 30 – Individual
- 35 – Individual
- 42 – Individual
- 138 – Kempsey Shire Council (KSC)
- 143 – Individual (Confidential)

Issue description

- 1) One community submission identified that portion of property number 70 in the environmental assessment for acquisition is affected by flooding from a pond on adjacent land.
- 2) Three community submissions expressed concerns about the potential changes to the existing flooding regime and drainage flows on the Hastings River floodplain as a result of the Proposal.
- 3) One community submission raised concerns that potential changes to the flooding regime may result in increased erosion and debris from floodwaters with subsequent impacts on tea tree plantations and machinery.
- 4) Two community submissions were concerned the Proposal would change the drainage in the area of Haydons Wharf Road and Wyndell Close and increase road runoff to properties in those areas.
- 5) Two community submissions expressed concerns about the potential changes to the existing flooding regime in the area of Cooperabung Close as a result of the Proposal.

- 6) One community submission expressed concern about the potential for damage to Barrys Creek and property boundary fence as a result of increased surface water runoff from the Proposal.
- 7) One community submission expressed concern over the potential flooding impacts on the property near Pipers Creek.
- 8) One community submission expressed concern over the potential increased surface water flow onto the property near the proposed Kundabung Road overpass.
- 9) The submission from KSC sought details regarding flooding information and how / if the new alignment will affect the current flooding within the shire including Hastings River, Maria River and Connection Creek.

Response

- 1) The advice is noted. Section 12.3.5 of the environmental assessment considers flooding impacts associated with the Proposal in the vicinity of Smiths Creek. The Proposal would not result in the worsening of flooding at this location. Further consideration would be given to flooding impacts during the detailed design phase.
- 2) As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The surface water flows and the potential flooding impacts associated with the Proposal were considered during the development of the concept design and measures to reduce the potential impacts have been incorporated into the design of the Proposal. The width of the opening for the bridges across the Hastings River and Fernbank Creek as well as several other proposed flood openings, on the floodplain on the northern and southern side of the river, have been designed to ensure the impacts are minimised. This includes minimising increases to water levels upstream of the structures, reducing the disruption to the natural hydrological regime and avoiding changes to the existing flow paths where possible. The location and size of the drainage culverts proposed for the floodplain will be refined in consultation with the relevant agencies following further flood modelling during the detailed design phase.

The potential flooding impacts on the Hastings River Floodplain, including the Fernbank Creek area, are discussed in section 12.3.2 of the environmental assessment. Details of potential changes in flood levels at several locations on the floodplain are presented in table 12-12 and the changes in flood behaviour for the 1 in 5 year, 1 in 20 year, 1 in 50 year, 1 in 100 year and extreme flood events on the Hastings River floodplain are presented in figures 12-2 to 12-12 of the environmental assessment.

- 3) As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The surface water flows and the potential flooding impacts associated with the Proposal were considered during the development of the concept design and measures to reduce the potential impacts have been incorporated into the design of the Proposal. Over 1,000 metres of bridge and culvert openings have been incorporated into the design of the Proposal across the Wilson River floodplain, including a 525 metre bridge across the river. The final number, location and width of the openings will be refined following further flood modelling during the detailed design phase. For flooding events larger than 1 in 20 years, the water will also flow over a large length of the road embankment in a similar manner to the current sheet flow situation on the floodplain. It would therefore be expected to have impacts similar to the existing situation for these flood events.

Section 12.3.3 of the environmental assessment discusses the potential flooding impacts of the Proposal on the Wilson River floodplain. The assessment identified a small increase in flood levels upstream of the Proposal with minor, localised increases in velocities near the outlets of the proposed flood relief structures. The velocity of the floodwaters at the flood relief structures is only expected to increase by 0.3 metres per second when compared to the existing flood velocities. The Proposal is not expected to increase erosion or the generation of debris during flood events. The Proposal is therefore unlikely to increase the amount of debris entering the existing tea tree plantation or generate erosion on the property. The need for scour protection measures near the flood relief structures would be further assessed during the detailed design phase.

Details of potential changes in flood levels at several locations on the floodplain are presented in table 12-19 of the environmental assessment and the changes in flood behaviour for the 1 in 5 year, 1 in 20 year, 1 in 50 year, 1 in 100 year and extreme flood events on the Hastings River floodplain are presented in figures 12-14 to 12-24.

- 4) As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The Proposal also includes longitudinal drainage systems designed to collect runoff from the road and direct it to existing local drainage lines. Measures to reduce the potential impacts on flow paths and patterns have also been incorporated into the design of the Proposal. Any adjustments required to the surface water drainage system in the area of Haydons Wharf Road and Wyndell Close would be designed to prevent additional impacts on properties from the potential increase in road runoff in those areas.
- 5) As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The surface water flows and the potential flooding impacts associated with the Proposal were considered during the development of the concept design. Measures to reduce the potential impacts on flow paths and patterns have been incorporated into the design of the Proposal.

The potential flooding impacts on Cooperabung Creek are discussed in section 12.3.4 of the environmental assessment. The assessment indicates that while there would be a minor increase in water levels upstream of the Proposal there would be no change in the flood levels or flood velocities downstream of the Proposal near Cooperabung Close. The service road bridge would also be designed with a 1 in 100 year flood level immunity.

- 6) The potential changes to surface water flows were considered during the development of the Proposal. Measures to reduce the potential impacts on flow paths and patterns have been incorporated into the design of the Proposal. As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The Proposal also includes a longitudinal drainage system designed to collect runoff from the road and direct it to existing local drainage lines such as Barrys Creek. The RTA acknowledges that there would be minor increases in runoff from the new road surface and into adjacent watercourses such as Barrys Creek. However the RTA considers that the management measures incorporated into the design of the Proposal would be sufficient to prevent additional scouring of the existing water courses. The management measures would be further refined during the detailed design phase following detailed ground survey.

- 7) As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The surface water flows and the potential flooding impacts associated with the Proposal were considered during the development of the Proposal and measures to reduce the potential impacts on flow paths and patterns have been incorporated into the Proposal.

The potential flooding impacts surrounding Pipers Creek are discussed in section 12.3.6 of the environmental assessment and the changes in flood height for three design events are presented in table 12-24. The assessment indicates that there would be an increase in water levels of up to 40 centimetres immediately upstream of the Proposal. However this increase would be reduced to zero approximately 200 metres upstream of the bridges. The increase in flooding levels would not impact dwellings upstream of the bridge. The flood modelling would be further refined during the detailed design stage.

- 8) As stated in section 6.4.15 of the environmental assessment, the design of the Proposal would generally allow the natural flow regimes to be maintained by incorporating transverse drainage structures such as bridges and culverts. The Proposal also includes longitudinal drainage system designed to collect runoff from the road and direct it to existing local drainage lines. The surface water flows and the potential flooding impacts associated with the Proposal were considered during the development of the concept design. Measures to reduce the potential impacts on flow paths and patterns have been incorporated into the design of the Proposal. The proposed Kundabung Road overpass is therefore not expected to result in increased surface water flow onto surrounding private property.
- 9) The hydrologic model used to assess the potential flooding impacts of the Proposal described in section 12.3 of the environmental assessment extends to include the entire catchment of the Hastings River, Forbes River, Pappinbarra River, Doyles River, Ellenborough River, Thone River, Mortons Creek, Wilson River and Maria River. The hydraulic model, which is in the vicinity of the Proposal indicates the impacts of the Proposal on flooding are minor and confined to the immediate proximity of the road embankment. The Proposal would not interfere with the Maria River floodway and it is not anticipated that there would be impacts on bank stability or any increase in erosion of the Maria River or Connection Creek.

2.10 Water quality

Submission numbers

5 – Individual
42 – Individual
136 – Department of Environment, Climate Change and Water (DECCW)
139 – Northern Rivers Catchment Management Authority (NRCMA)
141 – NSW Office of Water (NOW)

Issue description

- 1) One community submission expressed concern about increased surface water flows into Barrys Creek and the potential for impacts on water quality in the creek during construction.
- 2) Two community submissions raised concern over increased water runoff from the Proposal and the potential for a subsequent reduction in downstream water quality.

- 3) The DECCW submission advised that should flocculating agents be used during construction they must comply with strict toxicity ratings determined by NATA registered laboratory. Alum will not be suitable and uncontrolled placement of flocculating agents will not be allowed.
- 4) The NOW submission noted that the Proposal involves construction of bridges across major and minor watercourses and acknowledges the environmental assessment identifies the potential impacts and mitigation measures proposed to address the impacts. While the Proposal will not require a Controlled Activity Approval under the *Water Management Act 2000*, NOW requests that any works within 40 metres of a watercourse would be consistent with the State policy and guidelines.
- 5) The NRCMA submission suggested that the Proposal has the potential to conflict with the intent and achievement of some water and biodiversity targets contained in the Northern Rivers Catchment Action Plan (NRCAP).

Response

- 1) As discussed in section 6.4.15 of the environmental assessment, the RTA would avoid making changes to the existing flow paths where possible. Where changes to existing flow paths are identified, suitable mitigation measures would be developed during detailed design phase in consultation with the relevant agencies. The potential impacts on water quality of Barrys Creek during the construction of the Proposal are discussed in section 13.3.1 of the environmental assessment and the water quality management measures proposed during the detailed design and construction phases are discussed in section 13.4.1 of the environmental assessment. The construction management measures would be further refined during the detailed design phase.
- 2) The RTA acknowledges that there would be some increase in surface water run off from the Proposal. However as stated previously in this submissions report the Proposal incorporates drainage structures to manage surface water flow. The RTA would implement erosion and sediment controls to reduce the generation of pollutants and minimise impacts on adjacent receiving environments including rivers and creeks. The RTA would also maintain a water quality monitoring program to assess the effects of construction until all affected areas have been fully stabilised and revegetation work has resulted in the establishment of sustainable vegetation cover. Proposed management measures for the operational phase are detailed in section 13.4.2 of the environmental assessment. These include permanent water quality basins and vegetated swales which would be designed to meet the water quality objectives and to protect sensitive waterways.

Permanent water quality basins would be placed at locations where alternative treatment measures such as vegetated swales cannot achieve the water quality treatment objective and where spill containment measures would be required. The provision of permanent basins would be subject to specific site constraints.

- 3) The advice regarding flocculating agents is noted. The type of flocculating agents and their use would be reinforced in the Construction Environmental Management Plan to be developed prior to construction of the Proposal. They would comply with toxicity ratings, and their use would be strictly controlled.
- 4) The RTA would ensure that any bridge and road works undertaken within 40 metres of a watercourse would be consistent with the relevant State policy and guidelines to manage impacts.

- 5) The RTA considers that the management and mitigation measures incorporated into the Proposal would not impede the achievement of the water and biodiversity targets contained in the NRCAP.

2.11 Groundwater

Submission numbers

- 5 – Individual
- 11 – Individual
- 136 – Department of Environment, Climate Change and Water (DECCW)
- 141 – NSW Office of Water (NOW)

Issue description

Four submissions raised the issue of groundwater impacts as a result of the Proposal.

- 1) One community submission is concerned that the Proposal may impact the spring fed dam on their property at Cooperabung Close.
- 2) One community submission is concerned that the ground water level on the Wilsons River floodplain near the tea tree plantation could be lowered and expose acid sulfate soils.
- 3) The DECCW and NOW submissions acknowledged the commitment to carry out further groundwater modelling during the detailed design stage and advised that modelling must be undertaken by a suitably qualified groundwater consultant.
- 4) The DECCW and NOW submissions noted that the environmental assessment has outlined the main groundwater impacts associated with the Proposal and that these impacts are likely to be localised.

Response

- 1) The potential impacts on groundwater are discussed in section 14.3 of the environmental assessment. The Proposal consists of a low fill in the area adjacent to the Cooperabung Close property. While there may be some minor impacts on groundwater levels adjacent to the cut to the south of Cooperabung Creek the assessment indicates that the alluvial aquifer in the area near Cooperabung Close is unlikely to be impacted by the Proposal. The RTA will be undertaking additional groundwater modelling during the detailed design phase of the project to refine the measures to manage the potential impacts on groundwater.
- 2) The potential for acid sulfate soils to impact water quality is discussed in section 13.3 of the environmental assessment, with the acid sulfate soil management measures discussed in section 13.4. The potential groundwater impacts of the Proposal are discussed in section 14.3 and 14.4 of the environmental assessment and the measures to manage those impacts are discussed in section 14.6. The Proposal is on fill embankment in the area adjacent to the tea tree plantation and it is unlikely that exposure of acid sulfate soils (in addition to what occurs under natural seasonal variation) would occur as a result of groundwater drawdown. However, the RTA has committed to carry out further groundwater investigations prior to commencing construction to assess the potential for changes in the groundwater table from construction activities (refer SoC SGW6). Where a potential impact is identified, the significance of the change and any resultant impacts would be determined. Where necessary, measures to manage the changes would be

designed and implemented in consultation with relevant government agencies during the detailed design phase.

The RTA is also committed to confirming the presence of, and managing, acid sulfate soils on the Proposal site in accordance with standard management measures (ref SoC SGW7).

- 3) All further groundwater modelling during the detailed design stage would be undertaken by a suitably qualified groundwater consultant.
- 4) The RTA acknowledges the comments made by DECCW and NOW in relation to localised impacts on groundwater as a result of the Proposal.

2.12 Flora and fauna

2.12.1 Terrestrial flora and fauna

Submission numbers

- 2 – Individual
- 6 – Individual
- 13 – Individual
- 22 – Individual
- 25 – Individual
- 41 – Individual
- 136 – Department of Environment, Climate Change and Water (DECCW)
- 138 – Kempsey Shire Council (KSC)

Issue description

- 1) Four community submissions raised concerns about the potential impacts on local vegetation, habitat and animals as a result of the Proposal. Specific issues raised included:
 - Potential for disturbance to the vulnerable species, Comb-crested jacanas who breed in ponds near the Proposal.
 - The opening of Rodeo Drive as a service road would increase chances of local wildlife being killed by vehicles.
 - Blackmans Point Road interchange provides no environmental benefit for wildlife management.
- 2) One community submission advised that Brush-tailed phascogales have been sighted on 3 separate occasions adjacent to the Caimcross State Forest near Wharf Road.
- 3) The DECCW submission notes that the SEPP 14 wetland mapping was found to be inconsistent with the ground observations during field validation and seeks further explanation and clarification of the nature or extent of these inconsistencies prior to the detailed design phase.
- 4) The DECCW submission recommended developing protocols to prevent the introduction or spread of *Phytophthora cinnamomi*, including establishing an initial sampling and testing regime.
- 5) The KSC submission advised that a Draft Koala Plan of Management has been prepared by Council which needs to be considered in the assessment of koalas within the alignment.
- 6) One community submission noted that the stand of *Acronychia littoralis* identified in previous studies was not identified on the figures in the environmental assessment and

questions whether or not further field survey was undertaken to confirm the presence of the species.

- 7) The NRCMA submission suggested that the Proposal has the potential to conflict with the intent and achievement of targets contained in the Northern Rivers Catchment Action Plan (NRCAP) in relation to biodiversity.

Response

- 1) The assessment of the potential impacts on threatened flora and fauna is presented in section 15.3 of the environmental assessment with the proposed management measures discussed in section 15.4. Additional information is also available in the Flora and Fauna Working Paper in Volume 2 of the environmental assessment.

The potential habitat for the Comb-crested jacana (*Irediparra gallinacea*) was identified within the Proposal boundary but limited to a small wetland around Fernbank Creek. However the species was not observed during the field surveys undertaken during the development of the environmental assessment. While the Comb-crested jacana may have been sighted in the area of the dam it is considered unlikely that the dam forms part of its habitat due to the open environment. The assessment of significance prepared as part of the Flora and Fauna Working Paper found that the removal of some of the wetland habitat was unlikely to displace the local population of this species.

The RTA acknowledges that the opening of Rodeo Drive has the potential to increase fauna mortality of species that forage near the road. However it is considered that the increase would be minor due to the low speed environment and the low volumes of traffic using the service road along with the mitigation measures included in the Proposal.

The proposed Blackmans Point interchange represents the best balance of environmental, engineering and social factors when compared with the alternatives investigated during the development of the Proposal. The Proposal includes the provision of a combined and incidental fauna crossings as well as aerial crossings in the vicinity of the interchange to minimise any potential impacts on wildlife.

- 2) The RTA notes the advice. The environmental assessment noted that there have been several recorded sightings of the Brush-tailed phascogale within 2 kilometres of the northern end of the Proposal. However, the species was not recorded within the study area during field survey work. Surveying for this species is difficult and it is considered that it is likely to occur in the larger tracts of bushland within the study area, including the Rawdon Creek Nature Reserve and Cairncross State Forest adjacent to Wharf Road. The maintenance and rehabilitation of fauna movement corridors are important to this species. The Proposal includes incidental and combined fauna crossings and rope crossings adjacent to Wharf Road to facilitate the movement of this species.
- 3) A ground survey of the published SEPP 14 wetland boundaries by Hunter Wetlands Research (HWR) in 2006 revealed that the extent of the wetland vegetation is not as extensive as suggested in the published maps. Some additional wetland areas were identified during the ground surveys that were not included in the published maps. These inconsistencies were identified using criteria developed by Adam *et al* (1985).

The boundary of the SEPP 14 wetlands would be surveyed during the detailed design phase to clarify the locations and permit appropriate management measures to be implemented during the construction phase.

- 4) The measures proposed to mitigate and manage weed infestation are discussed in section

15.4.2 of the environmental assessment and includes a commitment to develop protocols to prevent the introduction or spread of *Phytophthora cinnamomi* prior to construction in consultation with DECCW. This protocol would be part of the weed management strategy that would be developed as part of the construction environmental management plan in consultation with agencies prior to commencement of construction.

- 5) The Draft Koala Plan of Management prepared by KSC has been considered during the preparation of the environmental assessment (refer section 3.8.1 of Flora and Fauna Working Paper in Volume 2 of the environmental assessment). The Supplementary Ecology Assessment (see section 3.1 of this submissions report) prepared to address the proposed service road network as part of the Proposal has also considered the Draft Koala Plan of Management prepared by KSC.
- 6) Figure 6 of the Flora and Fauna Working Paper in Volume 2 of the environmental assessment reported two unconfirmed records of *Acronychia littoralis*. The first near Fernbank Creek and the second north of Cairncross State Forest. Field surveys at these locations (Section 3.6 of the Flora and Fauna Working Paper) did not find *Acronychia littoralis* but identified *Acronychia oblongifolia* (Common acronychia). There is no indication that the records were forwarded to the Australian National Herbarium for verification. The RTA's consultant ecologists concluded that the unconfirmed records were likely to be a misidentification of the species. The Proposal is therefore unlikely to remove, fragment, displace or disturb any local population of this species and there would be no risk of extinction of this species. Should pre clearing surveys indicate the presence of *Acronychia littoralis* the RTA would consult with relevant agencies to ensure any impact on the species is minimised.
- 7) Every effort would be made to minimise the extent of vegetation clearing necessary for construction of the Proposal, through planning the road footprint to minimise clearing and through various environmental management measures to be implemented during construction. The location of depots, worksites and ancillary areas required for construction would be planned to be located within existing cleared land near the Proposal where feasible.

The RTA notes the comments regarding the targets of the Northern River Catchment Action Plan (NRCAP). The RTA considers that the management and mitigation measures incorporated into the Proposal, including the development of a proposed offset strategy in accordance with Statement of Commitment F18, would not impede the achievement of targets contained in the NRCAP.

2.12.2 Aquatic flora and fauna

Submission numbers

4 – Individual
42 – Individual
137 – Industry and Investment NSW (I&I NSW)

Issue description

- 1) The I&I NSW submission advised that the environmental assessment generally addresses the issues of interest to the I&I NSW Fisheries Ecosystems Unit.
- 2) Two community submissions raised concerns about potential impacts on aquatic flora and fauna. Specifically the potential impacts on mangroves and wetlands adjacent to Fernbank Creek and the potential impacts on Barrys Creek during construction.

Response

- 1) The advice from I&I NSW is noted and appreciated.
- 2) The location of mangroves, seagrasses and wetlands are identified in figure 15-5 of the environmental assessment. Mangroves are located along the edges of the Hastings and Wilson rivers. There are no mangroves present at, or near, the location where the Proposal crosses Fernbank Creek.

The potential impacts on mangroves and wetlands are discussed in section 15.3.2 of the environmental assessment, including the impacts associated with the construction of the bridges and culverts incorporated into the Proposal. Table 15-13 of the environmental assessment provides a "worse case" estimate of the area of mangroves and seagrasses that could be impacted by the Proposal based on a six and ten metre buffer from the edge of the structures across the Hastings and Wilson rivers.

Swamp forest / wetland communities are identified on the alignment of the Proposal near Fernbank Creek. No SEPP 14 wetlands exist in this location. The potential impacts on those communities are discussed in section 15.3.2 of the environmental assessment and the management of those impacts are discussed in section 15.4.

The Proposal includes an extension on the downstream end of the existing multi-cell box culvert at Barrys Creek. The design of the extension would be refined following further hydraulic modelling during the detailed design phase. This would include measures to reduce the potential for erosion of the stream downstream of the culvert should it be necessary.

The Proposal includes measures to offset residual impacts on protected aquatic vegetation as discussed in section 15.4.7 of the environmental assessment. These measures would be discussed and agreed with DECCW and I&I NSW during the detailed design phase.

2.12.3 Habitat corridors/ fauna crossings

Submission numbers

- 29 – Individual
- 34 – Individual
- 41 – Individual
- 42 – Individual
- 136 – Department of Environment, Climate Change and Water (DECCW)
- 138 – Kempsey Shire Council (KSC)

Issue description

- 1) One community submission provided additional information about accidents involving koalas between Oxley Highway and Kempsey to assist the project team during the further development of the fauna management measures during the detailed design phase.
- 2) KSC recommends that all fauna corridors and proposed crossings be in accordance with DECCW guidelines.
- 3) One community submission noted that the existing Pacific Highway is a current barrier to fauna movement through regional and sub-regional wildlife corridors and suggests that the upgrading of this section of the highway "will provide fauna with safer options for their natural movements across the highway".

- 4) Two community submissions suggested that the Proposal will result in the division of habitat which will effectively isolate populations of threatened species and sought advice on measures that will be provided in the Proposal to reduce the current high road kill in wildlife corridors for existing migrating animals.
- 5) One community submission suggested that there is limited proof that underpasses and rope ladders are effective for fauna passage and requests that a fauna bridge be included in the Proposal in the Cairncross State Forest area.
- 6) One community submission supported the concept of a fauna overpass on Cooperabung Hill to support small trees and/or apparatus to assist in fauna movement.
- 7) One community submission requested that the Maria River bridge be upgraded to a combined fauna crossing with 'furniture' fitted to ensure safe movement of fauna.
- 8) The submission from DECCW raised a number of issues regarding the design of proposed fauna crossings as follows:
 - DECCW sought changes to, or clarification of, some fauna crossing structures identified in the Proposal.
 - DECCW recommended the location of dedicated Koala structures is refined using recent surveys and habitat mapping found in the KSC Comprehensive Koala Plan of Management.

Response

- 1) The information provided about accidents involving koalas between Oxley Highway and Kempsey will be used by the project team during the refinement of the fauna management measures during the detailed design phase.
- 2) The RTA would continue to consult with DECCW regarding the design of proposed fauna crossing structures during the detailed design phase.
- 3) The RTA acknowledges that the existing Pacific Highway offers limited opportunities for fauna movement through regional and sub-regional wildlife corridors. The RTA also acknowledges that the upgrading of this section of the highway would provide fauna with safer options for their natural movements across the highway. The Proposal has been developed to include fauna crossing opportunities in the form of incidental, combined and dedicated fauna crossings as well as glider poles and rope crossings. The RTA is also investigating opportunities to adjust the Proposal to incorporate median widening. A copy of the *Median Widening Assessment – Preliminary Scoping Investigation* is attached as Appendix C.
- 4) The RTA acknowledges that the existing highway divides habitat and is a barrier to fauna movement. However the Proposal includes measures to reduce the barrier effect and assist fauna movement between sections of severed habitat. Section 15.4.3 of the environmental assessment, discusses the measures incorporated into the Proposal to reduce the potential for adverse impacts on native wildlife as a result of habitat fragmentation, barrier effects and road mortality. These measures include dedicated fauna underpasses, combined drainage/ fauna movement culverts and aerial fauna crossings located at key points along the Proposal to increase habitat connectivity. Wildlife exclusion fencing used in conjunction with crossings help to prevent fauna entering the highway. The proposed locations of the dedicated, combined and incidental fauna crossings are shown on figures 15a to 15c and described in section 6.4.16 of the environmental assessment.

- 5) Fauna underpasses are used extensively on road infrastructure projects as they offer opportunities for fauna to move between areas of habitat without the threat of vehicle collision. RTA monitoring over the past 10 years reveals that fauna crossings as small as 1.2 metres high provide fauna movement for a range of fauna species. Similarly rope crossings have been utilised by a range of target species. The RTA acknowledges that the success of fauna underpasses relies on their placement within local, regional and sub-regional wildlife corridors as well as within areas with known fauna populations. Data gathered from habitat assessments and detailed fauna surveys conducted in the study area between 2005 and 2010 was used to identify the proposed locations of the fauna underpasses incorporated into the Proposal.

The construction of a fauna bridge within the Caimcross State Forest is not feasible due to design restrictions resulting from topographical and vegetation constraints. The topography in this location does not facilitate the construction of a fauna bridge and would require further property acquisition, vegetation clearing and fill placement in order to achieve reasonable grades across the fauna bridge. Such a fauna bridge would be cost prohibitive. Lowering the Proposal would also compromise the 3.0 x 3.0 metre fauna underpasses included in the Proposal in this area. However the RTA is investigating opportunities to adjust the Proposal in this area to incorporate median widening. A copy of the *Median Widening Assessment – Preliminary Scoping Investigation* is attached as Appendix C.

- 6) The RTA acknowledges that the existing Cooperabung Hill cutting is a barrier for fauna movement in the area of the cutting. The RTA also acknowledges the cutting is located on the edge of a regional movement corridor and the Cooperabung Creek Nature Reserve. The options for providing opportunities for fauna to cross the Proposal in this area were carefully assessed and the construction of a fauna bridge structure across the cutting was considered neither feasible nor reasonable due to the width and depth of the cutting. A fauna bridge would therefore be cost prohibitive in this area. However the Proposal includes several crossing structures within the movement corridor including a dedicated fauna underpass immediately south and north of the cutting as well as another dedicated crossing approximately two kilometres further north within the movement corridor. The Proposal also includes four combined crossings and a further five incidental crossings within the movement corridor north of Cooperabung Hill. Three locations within the movement corridor have also been identified as potential locations for the placement of rope crossings or glider poles to assist in arboreal fauna crossings. The RTA considers that the proposed crossings would provide for fauna movement in this location in a cost effective manner.
- 7) Consideration would be given to the installation of 'furniture' under the Maria River bridge during the detailed design phase.
- 8) The RTA has considered the issues regarding the design of fauna crossings raised by DECCW and responses to those issues are provided in table 2.1 below. The RTA confirms its commitment in section 15 of the environmental assessment that it would further consult with DECCW and other relevant agencies, during the detailed design of the Proposal. This includes a commitment to further consultation regarding the design of the fauna crossing structures incorporated into the Proposal.

Table 2.1: Responses to DECCW issues relating to the design of fauna crossings

Item	Issue	Response
a	DECCW suggested retained vegetation in the median and on road verges in the areas of glider habitat should be considered a priority over rope ladders and glider poles as it would not require the same level of maintenance. Potential locations for a widened median should be investigated.	The RTA commissioned a Median Widening Assessment – Preliminary Scoping Investigation in July 2010 to investigate the feasibility of widening the median at locations currently proposed for aerial fauna crossings (glider poles). The preliminary scoping investigation identified that the following locations be further investigated as part of a Stage I assessment: • Cairncross SF (Ch: 10000 to 11160). • Ballengarra SF (Ch: 23200 to 23940). • Maria River SF (Ch: 33760 to 34380). A copy of the Median Widening Assessment - Preliminary Scoping Investigation is provided in Appendix C. The Stage I detailed assessment into the feasibility of widening the median at these three locations would be undertaken during the detailed design phase should project approval be granted by the Department of Planning.
b	DECCW supported the process reported in the EA of determining the location for fauna crossing structures however skylights are not needed. Alternatively consideration could be given to use of split median combined with fauna fencing.	The RTA notes the advice regarding skylights in fauna crossing structures and would consider incorporating split medians, combined with fauna fencing during the detailed design, where feasible to do so.
c	DECCW recommended bridges are designed with no less than 3m split between carriageways. Bridge abutments should be constructed at 90 degree angles where fauna passage is 4m or less.	The design of bridges to be constructed as part of the Proposal would be finalised during the detailed design phase. The design of the bridge abutments would be influenced by several factors including the type and size of creek / watercourse crossed, potential flow through the structure, quality of the foundations for the abutment and the area available to construct the abutment. Where practicable, the abutments for bridges would be constructed vertically if the distance between the creek bank and the abutment is less than four metres for fauna passage. The provision of a three metre split between carriageways is not feasible as it would increase the footprint of the Proposal.
d	DECCW considered that the proposed fauna crossing structures will provide limited connectivity across the highway barrier. DECCW considers the use of combined structures unacceptable and the identification of "as few as 9 dedicated fauna crossings and several bridges" as insufficient. DECCW recommends placement of 3.0 metres x 3.0 metres box culverts every 500m	The Proposal incorporates 67 fauna crossing locations in the form of bridges, dedicated, combined and incidental fauna crossings as well as drainage culverts. The RTA considers the combined structures incorporated into the Proposal serve a useful purpose of offering fauna passage as well as drainage for the Proposal. Every effort has been made to maximise the size of the culverts to assist fauna movement within the constraints of the topography and engineering design requirements for the Proposal. As a result the 26 combined crossings identified in the Proposal include 15 box culvert structures sized 3.0 metres x 3.0 metres. The RTA confirms that the Proposal incorporates fauna crossings on average every 500m where it bisects regional corridors.

Item	Issue	Response
	where the highway bisects regional corridors.	The RTA advises that the conversion of all drainage structures to the recommended minimum 3.0 metres in height would result in a larger footprint for the Proposal and significant additional costs to the project. For example, the highway embankment across the Hastings River floodplain currently incorporates 2.1 metre high flood relief structures. Increasing these to 3.0 metre high structures would increase the footprint by around 5 metres in width and also potentially generate greater flooding impacts.
e	DECCW considered that the combined fauna / drainage structures to be too small and states that these structures should be no less than 3.0 metres x 3.0 metres in regional corridors and 2.4 metres x 2.4 metres outside regional corridors.	The proposed fauna crossings incorporated in the Proposal have been designed to maximise the opportunities for fauna movement whilst limiting the Proposal's footprint and ultimately the area of vegetation required to be cleared. The culverts have been designed to the maximum height possible. To amend all culvert designs to be either a minimum 3.0 metres x 3.0 metres in regional corridors and 2.4 metres x 2.4 metres outside regional corridors, will result in a wider footprint, greater area of land impacted, more vegetation clearing, increased property acquisition, potentially greater heritage impacts, higher embankment levels, higher cost, and higher traffic noise and amenity impacts. It should be noted that of the 38 fauna crossings identified outside mapped regional corridors in the Proposal 22 meet or exceed the 2.4 metres x 2.4 metres requirement. The RTA will further review the size of the crossing structures during the detailed design phase, however it is not considered feasible or reasonable to change the size of all the culverts to the size requested by the DECCW.
f	DECCW recommended that box culverts 3.0 metres x 3.0 metres or smaller are restricted to 50 metres in length to facilitate fauna movement and should longer culverts be required it is suggested to split the culvert in an area of fenced, low density vegetation.	The RTA notes the DECCW recommendation, however restricting the length of culverts to 50 metres is not feasible as the width of the Proposal varies between approximately 30 metres and approximately 105 metres. The RTA would consider incorporating split medians, combined with fauna fencing during the detailed design, where feasible to do so.
g	DECCW made several observations and recommendations regarding the design and construction of single and multiple cell culverts.	The final design of single and multiple cell culverts would be determined during the detailed design phase in consultation with DECCW.
h	DECCW recommend "all new bridges shall provide no less than 4 metres fauna passage on each bank".	The RTA notes the advice from DECCW and confirms that the bridges for the Proposal would be designed to provide as much area as possible for fauna movement. Where possible the design would aim to provide 4 metre passage, however the final area is subject to meeting a balance between the environmental and engineering constraints at each bridge location. The RTA would continue to consult with DECCW and other relevant agencies during the detailed design phase.

Item	Issue	Response
i	DECCW recommend dedicated fauna crossing structures "should be no less than 3.0 metres x 3.0 metres to be effective and designed and located so that they do not receive surface water runoff".	The RTA notes the recommendations from DECCW. The culverts incorporated into the Proposal for fauna crossing structures have been designed to the maximum height possible. To amend all dedicated fauna crossings to a minimum 3.0 metres x 3.0 metres will result in a wider footprint, greater area of land impacted, more vegetation clearing, increased property acquisition, potentially greater heritage impacts, higher embankment levels, higher cost and higher traffic noise and amenity impacts. The RTA will further review the size of the dedicated crossing structures during the detailed design phase, however it is not considered feasible or reasonable to change the size of all the dedicated crossing culverts to the size requested by the DECCW. The RTA will also ensure the surface water drainage near the dedicated fauna crossing culverts is designed to reduce the potential for run off to enter the crossing culverts.

The RTA provided responses to recommended changes and questions relating to fauna crossings in table 2.2 below.

Table 2.2: Responses to DECCW recommended changes and questions relating to fauna crossings

Station	Recommended changes and queries relating to fauna crossings	Response
1620	DECCW recommends a reinforced concrete box culvert (RCBC) of at least 3.0 metres x 3.0 metres is provided to facilitate the identified target species. The skylight should be removed from the Proposal and replaced with a split in the median if the culvert is greater than 50 metres in length. This is a dedicated fauna crossing designed to facilitate potential koala movement. The culvert should therefore be of sufficient height to incorporate post and rail fauna furniture of 2.0 metre height which will provide refuge from wild dog predation.	The RTA notes the DECCW recommendation and advise that table 6-2 of the Flora and Fauna Working Paper contains a typographical error and the dedicated fauna crossing at this location would be a 3.0 metres x 3.0 metres box culvert. The RTA has reviewed the Proposal and confirms that median cannot be split at this location due to alignment and property constraints.
2625	DECCW recommends a RCBC of at least 3.0 metres x 3.0 metres is provided to facilitate the target species. Additionally, there appears to be no vegetation on the west of the highway at this point. Fauna crossings are shown to be viable only if they link patches of vegetation.	The RTA notes the DECCW recommendation. However a review of the Proposal reveals that the maximum culvert size that can be installed at this location would be 3.0 metres x 2.7 metres due to the terrain and engineering constraints. The RTA also confirms that isolated vegetation does exist in close proximity to this crossing.
3605	The vegetation to the east of this culvert does not appear to be connected to larger remnants. DECCW does not recommend changing this structure but requires further understanding of its inclusion. If research has revealed potential koala movement at this site then DECCW recommends the structure is increased in size to 3.0 metres x 3.0 metres.	The RTA confirms that the crossing structure is not located within a movement corridor. However an opportunity to include the structure has been taken to enhance the opportunities for fauna movement in the area adjacent to a high traffic area and reduce the potential for fauna conflicts with highway and service road traffic.

Station	Recommended changes and queries relating to fauna crossings	Response
		A review of the Proposal reveals that the maximum culvert size at this location would be 3.0 metres x 2.1 metres. This crossing spans both carriageways and the service road and any changes to the culvert would result in a substantial change to the Proposal design.
10680, 11151 and 11692	The crossing structures at these points are located within a regional corridor and within an area of proposed glider crossing. Currently, there are no dedicated structures or bridges in this section of the upgrade. DECCW recommends these structures are combined with a median and upgrade to 3.0 metres x 3.0 metres to reflect the importance of maintaining connectivity within this regionally significant wildlife corridor.	The RTA acknowledges the importance of maintaining connectivity within the regional corridor and the wider state forest area and has taken every opportunity to incorporate crossing opportunities in these areas, including fauna crossings, rope crossings and glider poles. The RTA confirms that the incidental crossings located at stations 10,680 and 11,151 are located within the state forest adjacent to the mapped regional corridor and that the incidental crossing located at station 11,692 is located within the mapped regional corridor. The RTA has reviewed the Proposal and confirms that the culverts proposed at these locations are the maximum size possible due to terrain and engineering constraints.
28295	It is unclear to DECCW why the proponent proposed 2 x 3.0 metre x 3.0 metre dedicated fauna crossings adjacent to a bridge at this location. Bridge structures provide superior opportunities for fauna passage if designed appropriately and would presumably negate the need for the adjacent RCBC's. DECCW recommends that further justification for the current Proposal is provided or preferably the table is amended to consolidate fauna passage at the bridge and confirm that the bridge will be designed in a manner to facilitate effective fauna crossing.	The dedicated crossings have been incorporated into the Proposal at this location to provide continuous dry passage for fauna during high rainfall events in this area.
33390-37790	Given the high number of glider and koala records in this regional wildlife corridor, this section of the upgrade should be considered a priority area for incorporation of a retained vegetated median. Terrestrial fauna would also benefit from an opportunity to split box culverts in the median thereby reducing the overall perceived 'tunnel effect'.	The Median Widening Assessment – Preliminary Scoping Investigation contained in Appendix C recommended the area adjacent to the Maria River State Forest between Station 33760 to 34380 be further investigated for the potential for median widening during Stage 1 of the assessment. The Stage 1 assessment into the feasibility of widening the median at three locations would be undertaken during the detailed design phase should project approval be granted by the Department of Planning. The RTA acknowledges the importance of fauna movement through this area as reflected in the Proposal. The Proposal

Station	Recommended changes and queries relating to fauna crossings	Response
		currently incorporates the following structures to facilitate fauna movement in this area: • One 3.0 metre x 3.0 metre dedicated crossing. • Two 3.0 metre x 3.0 metre combined crossings. • One 3.0 metre x 2.4 metre combined crossing. • One 3.0 metre x 1.8 metre combined crossing. • Stumpy Creek bridge consisting of 3 spans of 36 metres long. This section also includes the existing bridge crossing of the Maria River. The RTA has committed in section 2.12.3 of this report to considering the opportunities for placement of furniture under the Maria River bridge to facilitate fauna movement.
34086	DECCW recommends a RCBC of at least 3.0 metres x 3.0 metres is provided to facilitate the target species.	The RTA has reviewed the Proposal and confirms that the culvert proposed at this location is the maximum size possible due to terrain and engineering constraints. Any changes would result in an increased footprint and further impact on flora and fauna.
347146	DECCW recommends a RCBC of at least 3.0 metres x 3.0 metres is provided to facilitate the target species.	The RTA understands that this location is a typographical error and the DECCW are referring to the proposed 3.0 metres x 3.0 metres combined crossing at station 34714. The RTA has reviewed the Proposal and confirms that the culvert proposed at this location is the maximum size possible due to terrain and engineering constraints.

2.12.4 Compensatory habitats and offsets

Submission numbers

29 – Individual

41 – Individual

136 – Department of Environment, Climate Change and Water (DECCW)

139 – Northern Rivers Catchment Management Authority (NRCMA)

Issue description

- 1) One community submission urged the RTA to liaise with DECCW and the Port Macquarie Koala Hospital should koala relocation be necessary.
- 2) One community submission and submissions from DECCW and NRCMA, raised the issue of offsetting and the need for an appropriate offsetting strategy.

- 3) Two community submissions raised concerns that koala habitat in the Kempsey area would be lost if the offsets for the Proposal involved purchasing habitat in areas such as Coffs Harbour or Port Macquarie. These submissions identified the Goolawah Estate as a suitable and local offset site due to its high conservation value.
- 4) One community submission suggested that there is no 'like for like' or 'maintain or gain' outcome for threatened species once the Proposal is constructed.

Response

- 1) The RTA will liaise with DECCW and other relevant stakeholders should koala relocation be necessary during the construction of the Proposal. Fauna management would generally be in accordance with the construction environmental management plan.
- 2) The proposed offset strategy is discussed in section 15.4.7 of the environmental assessment. A commitment to developing and implementing an offset strategy is contained in revised SoC F20.

The actual land exchange ratio agreed with the DECCW and I&I NSW for the biodiversity offset strategy has varied from project to project over the last 14 years. However, the general land exchange ratio adopted is about 2:1 for native vegetation, and about 4:1 for endangered ecological communities, on a like-for-like basis. The offset strategy would also consider any agreement between the RTA and Forests NSW regarding offsetting impacts on state forest.

Further to this, the RTA's biodiversity offset strategy also includes revegetation in strategic locations and investment in management research related to the rehabilitation and protection of threatened species. To date, the area of compensatory habitat provided for the Pacific Highway upgrade program is about 1200 hectares. The RTA is continuing to negotiate offset packages for projects that are under construction or in the project planning stage.

All biodiversity offsets would be located within the NSW North Coast Bioregion with the aim of offsetting on a like for like basis based on broad vegetation type. The offset areas will be assessed to ensure that habitat for impacted threatened species is included in offset areas. Where it is not feasible to offset on a like for like basis other vegetation types of a similar conservation value that contain habitat suitable for the impacted threatened species will be considered in consultation with DECCW.

It is recognised that the availability and suitability of land for inclusion in the offset package will be uncertain until the detailed investigation of suitable sites and finalisation of negotiations with landholders occurs. As a result it is necessary to have a staged approach to determining the suitability of sites for inclusion in the package.

Priority 1

The first phase of the offset strategy would be to identify land that could be included in the package that meets the following criteria:

- Properties located within 30km radius of the project extending to 100km with the agreement of the Department of Planning and DECCW where it can be demonstrated that a suitable offset could not be found.
- Offset land would contain vegetation communities impacted by the proposal.
- Land would be assessed as to its suitability as habitat for the threatened species impacted by the project (including patch sizes) based on DECCW threatened

species profiles databases.

- Offset land would comprise vegetation of at least moderate to good condition (according to DECCW native vegetation benchmarks database).
- Offset land would comprise land that enables connectivity between adjacent areas of vegetation.
- Offset land must be suitable for ongoing management for conservation through an appropriate legal instrument.

Priority 2

The second phase, if required, would be to identify other land that either comprise properties located within the broader North Coast Bioregion or consists of similar vegetation communities within the broad vegetation types impacted by the proposal. The other criteria included in Priority 1 would still apply to lands considered under Priority 2.

The second phase would only be undertaken if the offset requirements could not be met from Priority 1 criteria and after consultation with DECCW and Department of Planning. The package would clearly identify the outcomes of the assessment of properties under Priority 1 criteria and identify if any Priority 2 properties were required to be included in the package to meet the objectives of the Strategy.

Notwithstanding the above the offset package may also be part of a larger offset package where other Pacific Highway projects may be included. The scope of this larger offset package would be determined using the same methodology as described in this report and would potentially allow larger more continuous areas of land to be acquired leading to improved conservation outcomes and economies of scale. Conservation organisations have shown interest in this approach and are interested in working with RTA to identify and manage such lands.

Tools used to identify potential offset land include, but are not limited to RTA property databases and possibly through advertisements for expression of interest for the provision of land for conservation purposes.

To deliver the biodiversity offset the RTA may engage the services of an appropriate organisation to act as a third party offset agent to negotiate with landholders to secure conservation management of the land and negotiate appropriate covenants or agreements. Third party offset agents may include conservation organisations established for this purpose. There are also a number of private companies that offer specialist services in finding biodiversity offset lands. If suitable, the RTA would also consult with DECCW to pursue opportunities to purchase land that may be suitable for reserve estate with DECCW.

Condition and habitat assessment of the proposed offset lands would be undertaken to ensure the potential offset land(s) consist of appropriate vegetation type(s) and of adequate condition that meet the decision-making framework outlined above. This assessment would be undertaken by suitable qualified ecologists and the report prepared would be included in the Biodiversity Offset Package.

- 3) The measures that could be included in the proposed offset strategy are discussed in section 15.4.7 of the environmental assessment. One of the measures proposed in the strategy is for the RTA to purchase land as compensatory habitat for ongoing conservation. Any decision to purchase the Goolawah Estate or any other land would be made in line with the approved biodiversity offset strategy and following further consultation with the DECCW.

- 4) The RTA acknowledges that the construction of Pacific Highway projects has an impact on the local environment. The Proposal however includes a commitment by the RTA to develop and implement an offset strategy in consultation with DECCW and I&I NSW (refer revised SoC F20). The details of the offset strategy would be developed in consultation with DECCW and I&I NSW during the detailed design phase and include measures described in section 15.4.7 of the environmental assessment.

It is envisaged the offset strategy would offset impacts to endangered ecological communities and broad vegetation types on a 'like for like' basis. In addition to providing land offsets, the offset strategy may include, in consultation with DECCW, additional revegetation in strategic locations and/or investment in management research related to the rehabilitation and protection of relevant threatened species.

2.12.5 Mitigation measures

Submission numbers

29 – Individual

136 – Department of Environment, Climate Change and Water (DECCW)

139 – Northern Rivers Catchment Management Authority (NRCMA)

Issue description

- 1) The DECCW submission recommends using frog fencing and Brush-tailed phascogale fencing where these species are highly likely to occur.
- 2) The DECCW submission sought a firm commitment to provide artificial breeding ponds in locations of known or potential Green-thighed frog habitat during the detailed design.
- 3) The DECCW submission supported targeted surveys of the Green-thighed and Giant barred frog prior to construction and specific mitigation measures such as frog fencing and artificial habitat creation at targeted areas.
- 4) The DECCW submission stressed the importance of a final 'impact audit' to identify additional or unforeseen changes to impacts to biodiversity from those identified in the environmental assessment.
- 5) One community submission suggests installation of wildlife exclusion fencing along the entire length of the Proposal.
- 6) NRCMA notes that the Proposal passes through several regional corridors and advises that proposed revegetation / regeneration activities should take local provenance into account.
- 7) NRCMA advises that the Proposal corridor is 'excluded land' under the NSW *Native Vegetation Act 2003* and a licence for clearing would not be required.
- 8) NRCMA requests that the principle of 'maintain and improve' is applied to the Proposal.

Response

- 1) The RTA notes the recommendation by DECCW and confirms its commitments to erect fauna exclusion fencing at appropriate locations to direct fauna to crossing structures (refer SoC F18). The fauna fencing strategy will be developed in consultation with DECCW and the RTA considers that this would include consideration of the appropriate style of fence and its location.

- 2) As outlined in section 15.3.1 of the environmental assessment, consideration would be given to the location, size and design of any artificial habitat breeding ponds during the detailed design and construction stages in consultation with DECCW.
- 3) As outlined in section 15.4.1 of the environmental assessment, targeted surveys of the Green-thighed and Giant barred frog would be undertaken prior to construction and specific mitigation measures such as frog fencing would be implemented in areas identified during the assessment. Artificial frog ponds would be considered in accordance with SoC F11.
- 4) The final impact audit requested by DECCW would be considered as part of the monitoring program to be developed to assess the effectiveness of mitigation and offset measures (refer revised SoC F20). The program will be for a minimum of 12 months after construction completion.
- 5) Wildlife exclusion fencing has 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. The installation of fauna exclusion fencing for entire length of the Proposal is not considered necessary to manage these impacts.
- 6) The RTA is committed to taking local provenance into account for revegetation/regeneration activities (refer SoC F5).
- 7) The advice from the NRCMA is noted.
- 8) The offset strategy developed by the RTA in consultation with the DECCW and I&I NSW would include the purchase of land to offset vegetation loss due to the construction of the Proposal. This approach is consistent with recent Pacific Highway Upgrade Program projects. This offset strategy for the Pacific Highway Upgrade Program would contribute to the long term conservation of biodiversity. The general land exchange is on a 'like for like' basis. This approach is considered to be consistent with the 'maintain and improve' principle under the NSW *Native Vegetation Act 2003*.

2.13 Noise and vibration

2.13.1 Construction noise

Submission numbers

- 3 – Individual
- 5 – Individual
- 10 – Individual
- 20 – Individual
- 42 – Individual
- 136 – Department of Environment, Climate Change and Water (DECCW)

Issue description

- 1) Five community submissions expressed concerns about noise from construction activities.
- 2) Two community submissions expressed concerns about noise from blasting.
- 3) The DECCW submission noted that the proposed construction hours are in excess of those recommended in the DECCW's *Interim Construction Noise Guidelines* (ICNG).

DECCW suggests that construction hours be restricted and project approval conditions include a post approval requirement to seek out of hours works in accordance with the process prescribed in ICNG.

Response

- 1) The assessment of construction noise impacts was undertaken in accordance with the DECCW ICNG, which specifies noise limits and working hours, amongst other requirements, for construction activities. The assessment identified potential noise generating activities and their approximate noise level impact at distances from the construction corridor. Where these impacts are predicted to exceed the guideline noise levels, specific mitigation measures would be implemented.

Where feasible, the implementation of operational noise mitigation measures may be considered prior to the commencement of construction to minimise noise impacts.

The construction activities specific to the Proposal would be assessed in greater detail during the detailed design phase when more information on the specific construction requirements are known. The construction contractor would also continue to consult with adjacent landowners and relevant agencies during the development of the Construction Noise and Vibration Management Sub Plan for the project. This Plan will contain appropriate measures to deal with potential noise impacts during the construction phase.

Where there are unacceptable noise impacts at residences or other sensitive receivers, affected parties would have the ability to register a complaint. Any complaints on the Proposal would be recorded and a process implemented to address and mitigate these issues.

- 2) The assessment of potential impacts from blasting activities has been prepared in accordance with the relevant environmental criteria and is provided in section 16.4.3 of the environmental assessment. The potential impacts of the blasting activities provided in the environmental assessment is an estimate based on the proximity of residences to major cutting along the Proposal. However, as detailed in the environmental assessment, the geotechnical subsurface profiles, blasting and seismic details would be determined during the detailed design phase. The overpressure and vibration predictions from blasting activities at residences would be further refined following these geotechnical investigations.

The buffer zone associated with the blast site would be identified and appropriate measures implemented to limit overpressure and vibration to acceptable levels. Blast charge and configurations would need to be selected to ensure that the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (1990) adopted by the DECCW are not exceeded.

Blasting would be monitored to confirm predicted overpressure and vibration levels. Blast design and buffer zones would be modified, if required.

- 3) The RTA notes the comments from the DECCW and acknowledges that the proposed construction hours are outside the standard hours recommended in the ICNG. However, as discussed in section 16.6.1 of the environmental assessment the proposed construction hours provide considerable benefit to the community and the project by reducing the length of the construction period and therefore reducing the duration of exposure to construction activities. The identification of the proposed longer working hours in the environmental assessment has allowed for consultation with the community and it should be acknowledged that no individual submissions have been received in relation to this

issue. The RTA is committed to including provisions (refer SoC CN3) to review the proposed construction hours as part of the Noise and Vibration Management Plan that would be prepared for the project prior to construction.

Where feasible, the implementation of operational noise mitigation measures may be considered prior to the commencement of construction to minimise noise impacts.

2.13.2 Operational noise

Submission numbers

- 3 – Individual
- 4 – Individual
- 10 – Individual
- 15 – Individual
- 17 – Individual
- 19 – Individual
- 20 – Individual
- 23 – Individual
- 30 – Individual
- 32 – Individual
- 33 – Individual
- 35 – Individual
- 136 – Department of Environment, Climate Change and Water (DECCW)

Issue description

- 1) The DECCW submission noted the procedure used to model the traffic noise is appropriate.
- 2) Eleven community submissions expressed concerns over the increase in noise pollution as a result of the Proposal due to an increase in traffic noise.
- 3) One community submission stated that road noise has increased with B-doubles going over existing bridge.

Response

- 1) The advice from DECCW is noted.
- 2) The traffic noise assessment included in section 16 of the environmental assessment was prepared in accordance with the requirements of the DECCW guideline *Environmental Criteria for Road Traffic Noise* (ECRTN) and the RTA's *Environmental Noise Management Manual* (ENMM). The traffic noise assessment identified sensitive noise receivers where the traffic noise levels are likely to exceed the ECRTN goals. The assessment also identified receivers already affected by road traffic noise as well as newly affected receivers.

The RTA acknowledges that as result of the Proposal some residents will experience traffic noise at higher levels than previously experienced and some residents will experience traffic noise from a different direction. However there are also a large number of residents who will experience a reduction in traffic noise levels as a result of the Proposal.

The RTA is committed to implementing reasonable and feasible noise mitigation measures to manage the impacts of traffic noise as discussed in section 16.6.4 of the environmental assessment. These measures would be further discussed with DECCW and relevant landowners during the detailed design phase.

Further information regarding potential noise levels at individual receiver locations and detailed results of the noise modelling can be found in Noise and Vibration Working Paper in Volume 3 of the environmental assessment.

- 3) The RTA notes the advice and acknowledges that the number of vehicles using the existing Pacific Highway and the Dennis Bridge has increased over time and as a result, there would have been some increase in traffic noise levels. Following construction of the Proposal, heavy vehicle traffic on the existing highway is expected to decrease as the existing Pacific Highway becomes part of the service road network. A corresponding decrease in traffic noise is expected.

2.13.3 Noise mitigation

Submission numbers

15 – Individual
17 – Individual
22 – Individual
25 – Individual
45 – Individual
136 – Department of Environment, Climate Change and Water (DECCW)
143 – Individual (Confidential)

Issue description

- 1) The DECCW submission noted that SoC ON1 and SoC ON2 commit to further consideration of operational noise mitigation measures during detailed design and post construction compliance assessment measures.
- 2) The DECCW submission requests further information to support the decision for the preferred receiver based mitigation options through the qualitative process outlined in the RTA ENMM.
- 3) Three community submissions requested that specific noise mitigation measures be adopted at private properties.
- 4) Two community submissions expressed concerns that the proposed noise mitigation measures are not satisfactory due to cost of running air conditioning and impact on outdoor lifestyle.
- 5) The DECCW submission recommended several adjusted conditions of approval from the Kempsey to Eungai Pacific Highway Upgrade, be imposed by the Department of Planning.

Response

- 1) SoC ON1 and ON2 confirms the RTA's commitment to further refinement of operational noise mitigation measures during the detailed design phase and review of the post construction compliance of the mitigation measures.
- 2) The decision to proceed with receiver based mitigation was based on the isolated nature of residences along the Proposal. The affected residences (92) are dispersed over the 37 kilometre length of the Proposal, being essentially a rural and rural-residential environment. Typically the residences are isolated, or in close groups of two or three only. All properties were assessed for noise barrier options based on the prediction of benefits that could be achieved at the most affected residence. In the case of residences that are clumped together a greater benefit is achievable, however the minimum performance criteria still apply. Where the minimum performance criteria for a noise barrier cannot be achieved, architectural or at property treatments have been recommended.

In accordance with Practice Note IV of the RTA's ENMM, architectural treatments are offered as they are very likely to be more cost effective. Noise walls were considered as an option for the Moorside Drive rural residential subdivision, south of Telegraph Point. Barriers would not be reasonable or feasible at this location due to significant adverse impacts on flooding, as well as the associated cost and engineering issues of construction of the barrier on a flood affected embankment. The highway embankment is on the Wilson River floodplain, with a road height set at the 20 year flood level. Implementation of a noise barrier that effectively reduced noise impacts on adjoining receivers would create a significant barrier to flood flows, thereby increasing flood levels upstream of the Proposal and creating erosion potential.

- 3) The RTA would consult with each landowner where the predicted traffic noise level would exceed the ECRTN criteria prior to determining the type of noise mitigation measures adopted properties (Refer ON1). All affected landowners would continue to be consulted during the detailed design and construction phases of the project.
- 4) There are a range of architectural treatments that would be considered by the RTA and discussed with landowners to improve the amenity at each affected residence. The measures adopted for each property would vary and would include some of the following options:
 - Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors shut.
 - Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures.
 - Upgrading window and door seals.
 - The sealing of wall vents, eaves and roofs.
 - The installation of external courtyard screen walls.
- 5) The RTA notes the request to adopt the adjusted Kempsey to Eungai conditions of approval for the Oxley Highway to Kempsey Project. Table 2.3 provides comments on the changes recommended by DECCW to the conditions.

Table 2.3: Responses to DECCW changes to conditions

K2E Condition	DECCW recommended revisions	Response
2.12	It is recommended that standard construction hours are reflected in the project approval as conditions 2.13 & 2.14 allows for consideration of out of standard hour work.	The RTA acknowledges that the environmental assessment is seeking approval for undertaking work outside of the standard hours prescribed by the ICNG. Additional mitigation measures have been included to address any complaints received by the community/individuals including reverting to standard construction hours in any construction area where complaints cannot be resolved to the satisfaction of all parties. The environmental assessment process is seen as an open and transparent process in which community can be informed of the intended construction hours and that a progression of works can occur without causing serious impact to the community. It should be acknowledged that no individual submissions have been received in relation to this issue. Construction hours can be reviewed as part of the Noise and Vibration Management Plan to be prepared for the Proposal.
2.14	Amend Condition 2.14(d) to reflect following text: <i>"accompanied with a noise impact assessment consistent with the requirements of the Interim Construction Noise Guideline (DECCW, 2009)".</i>	The RTA acknowledges the advice from DECCW in relation to Condition 2.14(d). The management measures identified in section 16.6.2 of the environmental assessment and SoC CNI are considered to encompass this requirement in accordance with the ICNG.
2.17	Recommended to DoP that the following text replace this condition: <i>"Construction Noise Management levels (CNML) shall be established using the Interim Construction Noise Guideline (DECCW, 2009). Any construction activities identified as exceeding the CNML shall be managed in accordance with the Construction Noise and Vibration Management Plan (CNVMP) specified in Condition 6.5c of this approval".</i>	The RTA acknowledges the advice from DECCW in relation to Condition 2.17. The management measures identified in section 16.6.2 of the environmental assessment and SoC CNI are considered to encompass this requirement in accordance with the ICNG.
6.5c	Inclusion of additional point: <i>"vi) The CNVMP shall be generally consistent with the guidelines contained in the Interim Construction Noise Guidelines (DECCW, 2009)".</i>	The RTA acknowledges the advice from DECCW in relation to this condition. The management measures identified in section 16.6.2 of the environmental assessment and SoC CNI are considered to encompass this requirement in accordance with the ICNG.

2.14 Visual amenity and urban design

2.14.1 View loss

Submission numbers

2 – Individual
3 – Individual
4 – Individual
10 – Individual
22 – Individual
32 – Individual
35 – Individual
45 – Individual
143 – Individual

Issue description

- 1) Five community submissions expressed concerns about the impact of the Proposal on the views from properties.
- 2) One community submission rejected the conclusions of the environmental assessment regarding the visual impact of the Kundabung Road overbridge when viewed from property is not considered negligible.
- 3) Two community submissions requested that landscaping and a wall or earthmound be installed to reduce the visual impact on properties.
- 4) One community submission suggested moving Blackmans Point interchange to a new location (Bill Hill Road) and replace with two bridges to reduce visual impact.
- 5) One community submission objected to Kundabung Road overbridge due to the visual impact caused from the loss of vegetation.

Response

- 1) Section 17.3 of the environmental assessment acknowledges that there would be temporary visual impacts during the construction of the Proposal for some residents as well as some permanent changes to the visual character following the completion of the Proposal. The Proposal includes measures designed to minimise the visual impact by adopting urban design principles that help create an interesting but unobtrusive road design. These measures are discussed in section 17.4 of the environmental assessment and include the development and implementation of a detailed urban and landscape design plan. The urban and landscape plan would include screen planting along the side of the Proposal in appropriate locations to minimise the view of the highway. This could involve shrub plantings to break up the view of the highway from residences but not restricting the views from the residences.

The RTA's commitment to delivering a project with minimal visual and amenity impacts is confirmed in the statement of commitments included in Appendix B of the environmental assessment (refer SoC VAD1, VAD3 & VAD5).

- 2) The RTA notes the advice from the respondent. Section 17.3 of the environmental assessment acknowledges that there would be temporary visual impacts during the construction of the Proposal for some residents as well as some permanent changes to the visual character following the completion of the Proposal. The new structures included in the Proposal, such as the Kundabung overbridge, have the potential for a greater impact

than other features of the Proposal. The Proposal includes measures designed to minimise the visual impact by adopting urban design principles that help create an interesting but unobtrusive road design. These measures are discussed in section 17.4 of the environmental assessment and include the design of the structures and the implementation of landscaping around the structures.

- 3) The Proposal includes measures designed to minimise the visual impact by adopting urban design principles that help create an interesting but unobtrusive road design. These measures are discussed in section 17.4 of the environmental assessment and include the development and implementation of a detailed urban and landscape design plan. The urban and landscape plan would be developed to reduce visual impacts of the Proposal through design and landscape treatments focusing on revegetation and integration with the existing landscape. The urban and landscape plan would include screen planting along the side of the Proposal in appropriate locations to minimise the view of the highway. The use of screen mounds and walls would be further considered during the detailed design.
- 4) The RTA notes the suggestion. However, as discussed in section 17.3.2 of the environmental assessment, the Blackmans Point Road interchange would be visually enclosed within the heavily vegetated Cairncross State Forest. The RTA does not propose to relocate the interchange.
- 5) The RTA notes the objection to the location of the Kundabung Road overbridge. The RTA acknowledges that the Kundabung Road overbridge would require the removal of some vegetation. However, the removal of the vegetation is not expected to result in a visual impact from the subject property as the vegetation which exists between the proposed overbridge and the residence on the subject property would not be impacted.

2.15 Traffic and transport

2.15.1 Travel times

Submission numbers

- 2 – Individual
- 5 – Individual
- 20 – Individual
- 31 – Individual

Issue description

- 1) One community submission expressed concern about increased travel times to local destinations due to the loss of existing direct highway access.
- 2) One submission from a resident in Cooperabung Close expressed concern that the arterial standard option would result in increased travel distance compared to the motorway standard.
- 3) One community submission expressed concern over the proposed traffic arrangement at Sancrox Road/ Fernbank Creek Road due to increased travel distance.
- 4) One community submission raised concerns about the extra travel distance required for northbound vehicles to access Hastings SES Community Driver Reviver Centre.
- 5) One community submission expressed concern over the Blackmans Point Road interchange as it provides no efficiencies in energy savings or cost savings.

Response

- 1) The RTA acknowledges that some residents will have longer travel distances which could result in slightly longer travel times following the removal of direct accesses to the highway. However the change in access also improves the safety for residents accessing the highway via service and access roads and interchanges and removes the need for the residents to make right turn movements across high speed highway traffic. It should also be noted that the Proposal would be designed for vehicles to travel at up to 110 kilometres per hour and would be a superior design to that currently offered by the existing highway. The RTA considers that the increase in travel time resulting from the loss of direct highway access would be outweighed by the improved safety and standard of the highway.
- 2) The RTA notes the concern of the Cooperabung Close resident and confirms that the arterial standard staging option for the Proposal would result in an increase in travel times compared to those offered by the final motorway standard. However the adjusted access to Cooperabung Close would remove the need for residents to make right turn movements across high speed highway traffic and would improve the safety for residents accessing the highway.

As noted in the environmental assessment, the decision on the staging option to be adopted for the construction of the Proposal would be subject to the availability of funding and priorities within the Pacific Highway Upgrade program.

- 3) The RTA acknowledges that the proposed Sancrox Road and Fernbank Creek Road traffic arrangement would add approximately 1.5 kilometres to the trip for people on the western side of the Proposal wishing to travel south from Sancrox Road as well as those people travelling north from Fernbank Creek Road. There would be no change to the remainder of manoeuvres from this location. However the proposed traffic arrangement would remove the need for residents to make a right turn movements across high speed highway traffic and provide a safer access across to the upgraded highway.
- 4) Data collected over 29 days between 17 December 2010 to 23 January 2011, reveals northbound visitors to the centre totalled 6,957 and southbound visitors totalled 7,990. Given the traffic generated by the centre, the RTA considers that the slightly longer travel times required to gain access to the centre would be offset by the safer access provided by the proposed traffic arrangement.
- 5) The proposed Blackmans Point interchange was designed taking into account environmental, social and economic considerations. The proposed interchange takes advantage of the existing topography in the area and minimises the impact on the environment. Its strategic location allows for efficient access to Telegraph Point and Blackmans Point Road whilst allowing for the deviation east of Telegraph Point. The utilisation of the existing terrain and the location closer to Port Macquarie would generate cost savings through using less construction resources, improved road grades and reduced travel times into the Port Macquarie.

2.15.2 Public transport and cycleways

Submission numbers

5 – Individual
20 – Individual
26 – Individual
135 – Transport NSW

Issue description

- 1) One business operator advised that the proposed service roads would be suitable for the company to operate local and school bus services and requested further consultation during the detailed design to ensure suitable facilities for bus stops are included along the service roads.
- 2) Concern was expressed by two community submissions over the safety of children using school buses for the arterial standard option due to the lack of stopping locations and need for the children to cross the highway.
- 3) Transport NSW requested that 2.5 metre wide shoulders along the Proposal be maintained on bridges and at pinch points to minimise conflict between cyclists and vehicles. Transport NSW also requested that opportunities to provide cycle way connections to adjoining communities should be investigated.

Response

- 1) The RTA acknowledges the support from the bus operator for the service road network. The RTA would continue to consult with public transport operators and the community regarding bus access and bus stop locations during the detailed design phase.
- 2) The RTA acknowledges the concerns of the residents. As discussed in section 18.3.2 of the environmental assessment there is no provision for bus stops along the upgraded highway in either the arterial standard staging option or the final motorway standard Proposal. The local bus services would use the upgraded local service road network in the final motorway standard option. The local bus services would use informal stops on local roads accessed by left in/ left out movements for setting down and picking up passengers. The concept design developed for the arterial standard staging option includes areas on local roads near intersections with widened verges to allow busses to stop. These locations are in areas of lower traffic volumes than either the existing or upgraded highway and, along with the prevention of right turn movements by buses across high speed highway traffic, would improve the safety for the bus operator and passengers when compared to the existing arrangements. As discussed in section 18.4 of the environmental assessment the RTA will continue to consult with public transport operators and the local community regarding bus stop locations and bus access.
- 3) As discussed in section 6.4.7 of the environmental assessment, no provision for pedestrian use of the main carriageway has been made due to safety reasons. Cyclists would be permitted to use the 2.5 metre shoulders of the Proposal. Signposting and crossing points would be provided for cyclists at the interchange and traffic arrangement ramps. Cyclists would be encouraged to use the service road network, which would offer a safer cycling environment due to lower vehicle speeds and traffic volumes.

Pedestrian footways would be provided across the main carriageways at the Sancrox Road overbridge (approximately 600 metres south of Sancrox Road) and the Kundabung Road overbridge. In addition, there would be opportunities for pedestrians to cross the

upgraded highway at other overbridges and vehicular underpasses, however no specific provision has been made due to anticipated low volumes of pedestrian traffic.

2.15.3 Rest areas

Submission numbers

33 – Individual
42 – Individual
141 – NSW Office of Water (NOW)

Issue description

- 1) Two community submissions asked that the proposed rest areas be relocated further south of their current location with one of the submissions concerned about the potential increased noise from trucks, anti-social behaviour, illegal camping and increased rubbish in Barrys Creek.
- 2) Environmental assessment does not outline how water will be supplied to the proposed rest areas.

Response

- 1) There are two rest areas located on the existing Pacific Highway that would be replaced as part of the Proposal. The location for the rest areas was carefully considered and several potential sites assessed against a range of engineering, road safety, social and environmental criteria to determine the most appropriate location. The existing sites were chosen to provide the best balance against those criteria. The location of the rest areas has been selected to minimise impacts on residents and the surrounding environment. The facilities proposed for the rest areas are discussed in section 6.4.9 of the environmental assessment. Waste disposal containers would be provided, with contents disposed of offsite on a regular basis. Overnight camping would be prohibited. The location of these rest areas has been taken into account in the noise modelling undertaken for the Proposal.
- 2) Page 98 of the environmental assessment states that “*Water for toilet amenities at the rest areas would be provided from on-site rainwater tanks, supplemented as necessary by water tankers.*”

2.15.4 Property access

Submission numbers

5 – Individual
22 – Individual
27 – Individual
28 – Individual
42 – Individual
138 – Kempsey Shire Council (KSC)
146 – Forests NSW

Issue description

- 1) Four community submissions and the KSC submission expressed concerns over disruption to property access during the construction period. Another community submission requested that an alternative property access be provided for water and sewerage vehicles

servicing the property.

- 2) One community submission stated that proposed changes to access will result in one of the property allotments and an adjoining property becoming landlocked.
- 3) The Forests NSW submission identified the need for access by Forests NSW haulage, management and emergency vehicles to existing state forest areas and trails to remain open at all times.

Response

- 1) The RTA would ensure that where any legal property access is temporarily or permanently affected by the Proposal, alternative access to an equivalent standard would be provided where feasible and reasonable or other alternative arrangements agreed in consultation with the property owner. Where alternative access arrangements are not feasible or practical and a property is left with no access to a public road, negotiations will be undertaken with the relevant property owners for the acquisition of the property in accordance with the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991*.
- 2) Access to the subject property would be further investigated during the detailed design phase to determine if an opportunity exists to provide an alternative access to the subject properties via the proposed service road.
- 3) Ongoing consultation would occur between the RTA and Forests NSW to ensure access to State Forest land is adequate. Where access to existing fire trails is impacted alternative arrangements would be made in order to maintain access. The service road network would be a public road under the control of the relevant council with normal access requirements rather than the restricted access arrangements under the Motorway conditions to be put in place for the upgraded highway. Forests NSW would therefore be able to negotiate with Council with regard to the position and/or adjustment of the access arrangements for ongoing State Forest operations.

2.16 Air quality

Submission numbers

4 – Individual
5 – Individual
30 – Individual
143 – Individual (Confidential)

Issue description

- 1) One community submission expressed concern over dust generated from construction impacting on tank supplied drinking water.
- 2) Three community submissions expressed concerns over an increase in air pollution as a result of the Proposal due to an increase in traffic and associated exhaust fumes.

Response

- 1) As discussed in section 20.1.3 of the environmental assessment, impacts associated with dust during construction would include dust generated by construction traffic, clearing groundcover and top soil, earth moving activities and the transport and stockpiling of soil and other construction materials. Measures that could be used to reduce and manage dust

emissions during construction are discussed in section 20.1.5 of the environmental assessment. Suitable measures for dust control would be included in the Air Quality Management Plan prepared prior to construction commencing.

- 2) The potential impacts on air quality as a result of the Proposal are discussed in section 20.1 of the environmental assessment and confirm that air quality would improve following the construction of the Proposal. This is the result of a higher standard of road and improved traffic flow patterns.

2.17 Geology and soils

Submission numbers

- 11 – Individual
- 25 – Individual
- 35 – Individual
- 136 – Department of Environment, Climate Change and Water (DECCW)

Issue description

- 1) Concerns were raised by two community submissions about the potential for bridge pylons to increase erosion at riverbanks and impacts on mangroves.
- 2) The DECCW submission supported the development of a water use and re-use sub plan and asked that water from sediment basins is reused wherever possible.
- 3) The DECCW submission noted that the environmental assessment does not indicate size or type of sediment basins that will be used. DECCW expect high level of erosion and sediment controls and encourage adequate areas for these structures
- 4) One community submission expressed concerns over the potential exposure of acid sulfate soils as a result of the Proposal.

Response

- 1) The concern about the potential for erosion around the bridge piers is noted. The bridge design will include measures to reduce the potential for erosion and scour to ensure the integrity of the bridge structure. The direction and velocity of the water flow would be considered along with the shape of the piers during the finalisation of the bridge design.
- 2) DECCW's support for the development of a water use and re-use sub plan is noted. The RTA also notes the DECCW request to re-use water from sediment basins on site and where practicable, and within the constraints of the construction activities and the requirement of the environmental protection licence, the RTA will investigate opportunities for re-use.
- 3) The concept design prepared for the Proposal includes indicative locations for sediment basins. The size, shape and location of the basins has been estimated using the guidelines *Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom 2004)* and *Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction (DECC 2008b)*. The size, shape and location of these basins would be further refined during detailed design and construction stages. Each basin would vary according to local conditions and sensitivity of water catchments.

- 4) As discussed in section 20.3.2 of the environmental assessment, a high risk of the presence of acid sulfate soil material has been identified in a number of areas along the Proposal (refer figure 20-2 of the environmental assessment for acid sulfate soil risk mapping relevant to the study area). The presence of acid sulfate materials in the study area is predominantly associated with alluvium material of the Hastings and Wilson River floodplains.

The operation and construction of the Proposal through areas of acid sulfate soils have been considered in the development of the concept design for the Proposal and would be further considered during detailed design. In addition, an Acid Sulfate Soils Management Plan (SoC GS2) would be developed for the Proposal. The plan would be developed in consultation with the relevant government departments and Port Macquarie Hastings Council. The RTA has guidelines for managing acid sulfate soils, which would be used in the development of the management plan and referred to throughout the construction phase.

2.18 Contamination

Submission numbers

41 – Individual

136 – Department of Environment, Climate Change and Water (DECCW)

Issue description

- 1) The DECCW submission notes that targeted contaminated soil investigations would be carried out during the detailed design phase and suggests that the investigations be based on historical evidence and carried out in accordance with DECCW guidelines.
- 2) One community submission asked if the environmental assessment identified a reported tributyltin (TBT) contamination issue in the Hastings River and seeks further information on the potential for the Proposal to liberate TBT from the river sediments during construction.

Response

- 1) Areas of potential soil contamination will be identified, investigated and appropriately managed in accordance with the relevant DECCW guidelines.
- 2) Section 20.4 of the environmental assessment discusses the preliminary assessment of land contamination sites that may be impacted by the Proposal. This assessment identified the potential for contaminants associated with the sand mining operation and slipway on the southern side of the Hastings River. However it should be noted that these sites are not directly impacted by the Proposal and it is considered unlikely that the construction of the Proposal would liberate TBT.

Section 20.4.4 of the environmental assessment outlines the proposed methods for the management of potentially contaminated land that would be impacted by the Proposal.

2.19 Clarifications to the environmental assessment

Submission numbers

25 - Individual

136 - Department of Environment, Climate Change and Water (DECCW)

Issue description

Three submissions sought clarifications to the environmental assessment.

- 1) One community submission advised that Property 19 identified as a 'non-travelling reserve' in table 10-4 of the environmental assessment either no longer exists or is seriously reduced in width.
- 2) One community submission advised that Properties 21 and 23 in table 10-4 of the environmental assessment are not 'council road reserve' but are privately owned roads.
- 3) One community submissions advised that there had been a change in ownership of Property 20 in table 10-4 and figure 10-3b of the environmental assessment.
- 4) The DECCW submission requested that the 'Description' column in table 6-2 of the environmental assessment be revised to include the height, width and length of the structures. DECCW also recommended that 'Range of species' column be expanded to include the range of species that are likely to use the structure.

Response

- 1) The RTA notes the advice regarding the reserve.
- 2) The RTA notes the advice and is currently seeking clarification as to the status of ownership of Properties 21 and 23 through appropriate legal enquiries. Once the correct ownership is identified, acquisition of affected land would be undertaken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.
- 3) The change of ownership has been noted.
- 4) Table 6-2 has been revised to reflect the DECCW requests. The revised table is contained in Appendix A.

2.20 Statement of Commitments

Submission numbers

136 – Department of Environment, Climate Change and Water (DECCW)

137 – Industry and Investment NSW (I&I NSW)

141 – NSW Office of Water (NOW)

Issue description

- 1) DECCW suggested that many commitments in the environmental assessment were not carried forward to the draft statement of commitments included in the environmental assessment. DECCW also suggested that the statement of commitments would be improved with the provision of more detail on the actions and measure that would be undertaken to avoid, minimise, manage, mitigate, offset and/or monitor impacts.

- 2) I&I NSW asked that all commitments in relation to the mitigation of impacts on farms and properties contained in the environmental assessment be listed fully in the statement of commitments.
- 3) NOW note the commitment to carry out further groundwater modelling during the detailed design stage and advised that the modelling must be undertaken by a suitably qualified groundwater consultant.

Response

- 1) The RTA notes the comments from the DECCW regarding specific commitments contained in the draft statement of commitments. Table 2-4 below provides a response to each of the issues and suggestions raised in relation to the statement of commitments (SoCs). It should be noted that the Statement of Commitments represent the broad and overarching measures proposed by the RTA to minimise potential impacts from the Proposal and are not intended to cover all specific issues relating to the Proposal. These commitments are supported by the management measures identified throughout the environmental assessment.

Table 2-4: Statement of Commitment amendment responses

Item	Agency	Suggested SoC amendment/comment	Response
Water quality and hydrology			
1	DECCW	DECCW notes that the use of water from sediment basins for such things as dust control is preferred to the use of town water or water from natural systems. DECCW recommends that an additional statement of commitment outlining a commitment to appropriate water use hierarchy. (Ref: Page 3 DECCW response - Attachment 1)	The RTA considers that the issues raised by DECCW are addressed in the draft SoC SGW11 and a separate SoC is not required. The water management plan would include actions and strategies to ensure water resources are used in the most efficient manner with a focus on achieving water savings and targeting water recycling and re-use.
2	DECCW	DECCW notes leachate from excess mulch can cause water pollution. DECCW recommends an additional statement of commitment relating to the storage, siting and removal of excess mulch. (Ref: Page 3 DECCW response - Attachment 1)	The RTA agrees that uncontrolled runoff from mulch stockpiles can cause water pollution and the management of pollution from the Proposal is a high priority. However the RTA considers that the management of mulch can be effectively addressed in the soil and water sub plan to the CEMP which will be forwarded to agencies for review and a specific SoC in relation to mulch is not required.
3	DECCW	DECCW notes that it is imperative that clean water diversion is implemented prior to earthworks commencing. DECCW recommends an additional statement of commitment in this regard. (Ref: Page 3 DECCW response - Attachment 1)	The RTA acknowledges that clean water diversion is a fundamental component of any erosion control and sediment plan developed for the construction of the Proposal. The early installation of clean water diversions is a priority for protection of surface water quality. However, the staging required for some construction works will not always permit the diversions to be installed prior to the commencement of earthworks. The erosion and sediment control plan prepared for the project would include erosion and sediment

Item	Agency	Suggested Commitment comment	Statement of amendment/	Response
				control measures to manage surface water. The plan would be prepared in consultation with DECCW. The RTA considers that an SoC dealing specifically with water diversions is not necessary as draft SoC SGW5 includes a commitment that soil and water management will be carried out in accordance with the relevant environmental guidelines.
4	DECCW	DECCW notes all bridges need to have adequate stormwater controls provided for operational use. DECCW recommends an additional statement of commitment in this regard. (Ref: Page 3 DECCW response - Attachment I)		All waterway crossings will be designed to ensure water quality is adequately protected. The detailed design of bridges will consider a range of factors including stormwater management, flood impacts and fauna crossing and will be developed in consultation with relevant agencies. The RTA considers that an additional SoC regarding a specific bridge design issue is not required.
Groundwater				
5	DECCW	DECCW recommends a new Statement of Commitment in relation to additional groundwater investigations where impacts of more than 5m drawdown on the watertable are likely. (Ref: Page 3 DECCW response - Attachment I)		The RTA considers that issues raised by DECCW regarding additional groundwater investigations are addressed in SOC SGW6.
Flora and fauna				
6	DECCW	DECCW recommends changes to SOC F16 - bridges and culvert design.		The RTA considers that the recommended changes to bridges and culverts identified in the DECCW submission have been addressed in section 2.12.3 of this report. It should also be noted that the RTA will continue to consult with DECCW and the relevant agencies during the detailed design phase and changes to the SoC are not required. Note: The draft SoCs contained in the environmental assessment contained two SoCs labelled as 'F16'. The revised draft SoCs appended to this submissions report have been amended and the SoC relating to bridge and culvert design has been renumbered SoC F17.
7	DECCW	DECCW supports the development of a Biodiversity Offset and Mitigation Strategy as outlined in SOC F18 and suggests that the Northern Rivers CMA vegetation mapping and DECCW's spatial layer of biodiversity conservation priorities be used to		The RTA acknowledges support for the Biodiversity Offset and Mitigation Strategy as outlined in revised SoC F20. The RTA would continue to consult with the DECCW regarding the suitability of offset areas based on a set-ratio approach to offset impacts to endangered ecological communities and broad vegetation types on a like for like basis.

Item	Agency	Suggested Statement of Commitment amendment/ comment	Response
		develop a potential offsets map based on the forest ecosystems and vegetation communities that correspond to vegetation communities impacted by the Proposal.	
8	DECCW	DECCW recommends SOC F19 be revised to include a minimum of 5 monitoring events over 10 years after construction is completed.	Revised SoC F21 commits the RTA to a targeted, adaptive monitoring program for a minimum of 12 months to assess the effectiveness of fauna and flora impact mitigation measures. After 12 months a report will be completed to assess the need for additional measures and/or further targeted monitoring in consultation with DECCW. The RTA considers that this monitoring approach is appropriate and changes to the SoC are not necessary. Note: SoC F19 has been renumbered to SoC F20 in the revised SoCs appended to this submissions report.
9	DECCW	DECCW recommends a new Statement of Commitment that states no barbed wire be used in any boundary fencing as part of the Proposal.	The RTA advises that it is not feasible to prevent the use of barbed wire fencing along the entire length of the Proposal's boundary. The fencing installed along the boundary of the Proposal must be suitable for the needs of the adjoining landholder and the risks associated with the adjoining land use. For example where RTA is installing a boundary fence in areas of farmland where stock are (or could be) grazed, fencing needs to be of a standard and design to prevent the stock entering the highway. Where the adjoining landholder is a government agency installation of non-barbed wire fencing would be considered where feasible. Where glider poles or aerial crossings are proposed, the impacts of barbed wire fencing in those locations will be considered and the design will be developed in consultation with DECCW.
Aboriginal heritage			
10	DECCW	The RTA will continue to consult meaningfully with and involve all of the registered Aboriginal stakeholders for the duration of the project in relation to the ongoing management of all Aboriginal cultural heritage matters relevant to this project. Evidence of this consultation must be documented and provided to the consent authority.	The RTA has committed (SoC AHI) to the development of an Aboriginal Heritage Management Plan which will address these issues. DECCW will be consulted on the development of the plan.

Item	Agency	Suggested Commitment Statement of amendment/ comment	Response
11	DECCW	The RTA will provide fair, equitable and reasonable opportunities for all of the local Aboriginal stakeholders to collect and salvage any Aboriginal objects likely to be impacted by the project.	The Aboriginal Heritage Management Plan developed to meet SoC AH1 will address these issues. SoC AH4 also provides for management of heritage items in consultation with Aboriginal stakeholders.
12	DECCW	The RTA will prepare an Aboriginal Heritage Management Plan for the project area.	This is included in SoC AH1.
13	DECCW	In the event that surface disturbance identifies a new Aboriginal site, all works must halt in the immediate area and a suitably qualified archaeologist and representatives from all local Aboriginal stakeholders. The site must also be registered in the Aboriginal Heritage Information Management System.	This is included in SoC AH3.
14	DECCW	If human remains are located, all works must halt in the immediate area and NSW Police contacted immediately and provide written notification to the RTA.	This is included in SoCAH3.
15	DECCW	All reasonable efforts must be made to avoid impacts to Aboriginal cultural heritage at all stages of works. If impacts are unavoidable, mitigation measures are to be negotiated with the local Aboriginal community and DECCW.	This is included in SoC AH4.
16	DECCW	An Aboriginal Cultural Education Program must be developed for the induction of all personnel and contractors involved in construction activities in collaboration with the Aboriginal community.	This is included in SoC AH5.

- 2) The RTA is committed to implementing the mitigation measures identified in the environmental assessment.
- 3) Further investigations and groundwater modelling during the detailed design phase would be undertaken by a suitably qualified groundwater consultant.

3 Additional assessment

3.1 Supplementary Flora and Fauna Assessment

The RTA engaged GHD to undertake ecological assessments of five additional study areas potentially impacted by the Proposal. These areas were not previously subject to an ecological survey as part of the environmental assessment for the Proposal.

The field surveys identified the flora and fauna values of the additional study area as being largely consistent with prior investigations reported in the environmental assessment and flora and fauna working paper.

3.1.1 Potential impacts

The Proposal would result in impacts on native biota and their habitats through the clearing of 5.8 hectares of native vegetation in the additional study area. This vegetation also includes 3.8 hectares of vegetation consistent with the following *Threatened Species Conservation Act, 1995* listed Endangered Ecological Communities (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 and are predominantly consistent with the estimates provided in these assessments. However some additional impacts have been identified within the additional study area with the key differences between the additional 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 (0.8 hectares).
- Loss of foraging habitat for the hoary wattled 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 species. On this basis it is considered that the Proposal continues to meet the 'maintain and improve test' under Part 3A of the *Environmental Planning and Assessment Act, 1979* when considered within the context of the proposed mitigation measures identified in the environmental assessment.

3.1.2 Management of impacts

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.

A copy of the Supplementary Flora and Fauna Assessment is contained in Appendix B.

3.2 Supplementary Aboriginal Cultural Heritage Assessment

3.2.1 Overview

A number of minor changes to the study area have been identified since the preparation of the environmental assessment, which are outside of the area originally investigated by South East Archaeology. Inspection and assessment of these areas is the subject of a supplementary report (South East Archaeology 2010b).

The minor changes to the study area include adjustments to the existing road network. Some of those roads would be modified to a standard suitable for use as service roads for the Proposal. The changes to the study area also include an extension to the proposed service road on the eastern side of the Proposal between the Maria River to the north of Stumpy Creek. These areas were not previously assessed as part of the detailed investigations.

The supplementary report prepared by South East Archaeology (2010b) is a confidential report that will not be released to the public in order to protect the Aboriginal heritage evidence referenced in the original confidential Aboriginal heritage report. A summary of the supplementary report is presented below.

3.2.2 Methodology

The survey was conducted using the same methodology as that approved by the registered Aboriginal stakeholders for the environmental assessment investigation (South East Archaeology 2010a). Some of the areas identified in the minor changes to the study area had been sampled during the environmental assessment investigation and therefore were not subject to further inspection.

Supplementary to the investigation undertaken for the Proposal (South East Archaeology 2010a), this additional assessment has involved:

- Review of previous searches of the DECCW Aboriginal Heritage Information Management System (AHIMS) and other relevant information.
- Archaeological survey of the study areas with representatives of the registered Aboriginal stakeholders following the same methodology and consultation procedures established for the main project (South East Archaeology 2010a). This was undertaken between 25 and 28 October 2010 by Stephen Free of South East Archaeology, accompanied within the Birpai LALC area by Lindsay Moran, within the Kempsey LALC area by Edward Smith and Troy Smith, and within the whole area by Isaac Campbell-Cook and Kevin Stewart of the Dunghutti Elders.
- Preparation of the supplementary report to present the results of the investigation, potential impacts of the Proposal and management recommendations.

3.2.3 Results

The total survey coverage (ground physically inspected for heritage evidence) equated to approximately 90,610 m². The total effective survey coverage (visible ground surface physically inspected with potential to host heritage evidence) equated to around 1042 m².

These totals do not include the previously surveyed areas. These totals also do not include portions of the investigation area that are 'modified' areas (including roads, houses, etc) which have been extensively impacted by previous works such that there is negligible potential for any Aboriginal heritage evidence to survive. Visual inspection was made of these modified areas to confirm that negligible potential for heritage evidence exists.

No Aboriginal heritage evidence was identified within the areas inspected and no Aboriginal heritage sites have previously been recorded in these locations. The registered Aboriginal stakeholders did not disclose any specific knowledge of any traditional or historical cultural values/places within these areas. However, the possibility cannot be excluded that traditional or historical Aboriginal values or associations may exist that were not divulged to South East Archaeology by the persons consulted.

The additional survey areas are located in areas that cannot be characterised as being within primary or secondary resource zones. Hence, consistent with the wider survey results and occupation model, a very low density of artefacts and potentially shallow low-density subsurface deposit of artefacts may occur. The potential for sub-surface deposits of artefacts that may be in situ and/or of research value is low to very low, considering the landscape formation history, shallow “A” unit soil, levels of ground disturbance and/or occupation model.

The potential for evidence in the areas totally impacted by recent land use is negligible.

3.2.4 Potential impacts

The potential impacts of the Proposal are presented in the Aboriginal Heritage Working Paper contained in Volume 3 of the environmental assessment and remain essentially unaltered. The Proposal will not result in any impacts to any identified heritage evidence within the area assessed for this supplementary report. The Proposal will not result in any material change to the extent of potential impacts as assessed in the environmental assessment (South East Archaeology 2010a) to the:

- Areas of cultural sensitivity (A-E);
- Areas of moderate to high potential for artefact deposits of research value around the Maria River, Pipers Creek, Smiths Creek and Cooperabung Creek;
- Areas of high potential for artefact deposits of research value north of the Wilson River or Hastings River; or
- Areas of low potential for skeletal remains.

The predictive model remains unchanged from that presented in the Aboriginal Heritage Working Paper.

3.2.5 Management of impacts

The management and mitigation measures proposed in section 10 of South East Archaeology (2010a), with consideration of legal requirements under the *National Parks and Wildlife Act 1974* and *Environmental Planning and Assessment Act 1979*, the results of the survey and sub-surface investigations, and consultation with the local Aboriginal community, remain unaltered by this supplementary assessment.

Single copies of the supplementary report would be forwarded to the registered Aboriginal stakeholders for their review and comment, and final copies of the report forwarded to DECCW.

3.3 Median Widening Assessment – Preliminary Scoping Investigation

The Proposal includes the provision for aerial fauna crossings at several locations to assist arboreal fauna movement in key fauna corridors. This includes the provision of rope ladder crossings and glider poles. Advice from DECCW during the planning of recent Pacific Highway upgrade projects led the RTA to initiate a median widening assessment in July 2010 to investigate the feasibility of widening the median at some of the locations identified in the Proposal for aerial fauna crossings (glider poles).

The median widening assessment would be developed as a three stage process.

- Preliminary scoping investigation. Identifying potential aerial crossing sites and the review of existing project information to determine the suitability of adopting median widening at the sites.
- Stage 1 – Detailed investigation. The sites identified as requiring further investigation would be subject to detailed investigation during the detailed design phase in consultation with DECCW.
- Stage 2 – Finalisation and approval.

A copy of the preliminary scoping investigation is attached to this submissions report in *Appendix C - Median Widening Assessment – Preliminary Scoping Investigation (GHD, 2011)*.

The preliminary scoping investigation identified the following three locations that will require further investigated for the potential for median widening as part of the Stage 1 of the assessment:

- Cairncross State Forest (Ch: 10000 to 11160).
- Ballengarra State Forest (Ch: 23200 to 23940).
- Maria River State Forest (Ch: 33760 to 34380).

Further investigation of the above sites as part of the Stage 1 assessment during the detailed design would include:

- Preliminary engineering design and cost analysis.
- Field investigations as necessary.
- Consultation with affected landowners and relevant agencies.
- Analysis to qualify the benefits and impacts based on the preliminary designs.
- Confirmation of those sites where median widening would be feasible and reasonable.

Following completion of the above tasks a workshop involving the RTA and relevant agencies to discuss the outcomes of the assessment.

4 Revised Statement of Commitments

The environmental assessment for the Oxley Highway to Kempsey Pacific Highway upgrade identified a range of environmental outcomes and management measures that would be required to avoid or reduce the environmental impacts.

After consideration of the issues raised in the public submissions, the draft statement of commitments for the Oxley Highway to Kempsey Pacific Highway upgrade (refer to section 8 of the environmental assessment) has been revised. Should the project be approved, the revised commitments will guide the subsequent phases of the Oxley Highway to Kempsey Pacific Highway upgrade development.

The following definitions apply in relation to the revised statement of commitments:

Pre-construction	Work in respect of the project that includes design, survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing ancillary facilities such as site compounds in locations which meet criteria identified in the environmental assessment, or other relevant activities determined to have minimal environmental impact (eg minor access tracks and adjustments to services/utilities etc).
Construction	All work in respect of the project other than that defined as a pre-construction activity/work.
Operation	The operation of the project, but not including commissioning trials of equipment, or temporary use of parts of the project during construction.

The revised statement of commitments, including commitments relating to the key issues described in the Director-General's environmental assessment requirements is provided in table 4-1. Additional and/or modified commitments to those presented in the draft statement of commitments have been highlighted and deleted commitments, or parts of commitments, have been struck out.

Table 4-1 Revised statement of commitments

Outcome	Ref. number	Key action	Timing	Reference document
Environmental management				
Compliance and continual improvement in environmental management.	EM1	The head contractor for the Proposal will have an environmental management system.	Pre-construction	ISO 14001. <i>RTA QA Specification G36 Environmental Protection (Management System).</i> All relevant RTA policies, specifications, guidance notes and environmental directions.
	EM2	Suitable qualified and experienced personnel will develop and implement project-specific environmental management plans and procedures. The environmental management plans and procedures will incorporate management measures identified in the environmental assessment.	Pre-construction and construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i> All relevant RTA policies, specifications, guidance notes and environmental directions.
	EM3	A construction resource plan will be developed to ensure there are adequate resources to undertake the proposed works according to programme.	Pre-construction and construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.
	EM4	The head contractor will implement a construction environmental management plan.	Pre-construction and construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i> All relevant RTA policies, specifications, guidance notes and environmental directions.

Outcome	Ref. number	Key action	Timing	Reference document
Communication and consultation				
An informed community.	CC1	The community will be provided with regular project updates, given prior notice of project activities and provided contact details for enquiries. Where required, affected individuals or groups will be consulted directly and provided with targeted notifications (eg watercourse users and noise affected residences).	Pre-construction and construction.	<i>Community Involvement and Communications, Draft: A resource manual for staff June 2008</i> AS 4269 Complaints Handling.
	CC2	The community will be able to make complaints using the project's 24-hour toll free complaints number or the project web page. The number will be publicised and the project-specific web page will include directions on how to register a complaint. All complaints will be acknowledged within a specified timeframe, recorded and tracked until resolved.	Pre-construction and construction.	Community Involvement and Communications, Draft: A resource manual for staff June 2008. AS 4269 Complaints Handling.
	CC3	A community consultation plan will be implemented.	Pre-construction and construction.	<i>Community Involvement and Communications, Draft: A resource manual for staff June 2008.</i>
	CC4	Consultation will take place between the RTA and Forests NSW and all other necessary agencies to agree management principles for Crown land.	Pre-construction and construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.

Outcome	Ref. number	Key action	Timing	Reference document
Land use and property				
Provide appropriate level of compensation in relation to property acquisitions.	LPI	All property acquisitions will be negotiated in accordance with the RTA Land Acquisitions, Policy Statement and compensation will be assessed under the provisions of the Land Acquisition (Just Terms Compensation) Act 1991.	Pre-construction	RTA <i>Land Acquisitions, Policy Statement. Land Acquisition (Just Terms Compensation) Act 1991.</i>
Maintain highway Access.	LP2	Where alternative access arrangements are not feasible or practical and a property is left with no access to a public road, negotiations will be undertaken with the relevant property owners for the acquisition of the property in accordance with the provisions of the <i>Land Acquisition (Just Terms Compensation) Act 1991.</i>	Pre-construction, construction and operation.	RTA <i>Land Acquisitions, Policy Statement. Land Acquisition (Just Terms Compensation) Act 1991.</i>
Maximise use of existing forestry resources.	LP3	Forests NSW will have access to areas of state forest land identified for acquisition to remove any harvestable timber within the footprint of the Proposal.	Pre-construction and construction.	
Access to water supply for properties maintained.	LP4	Where a licensed bore, dam or other property water supply is adversely affected the RTA will investigate an alternative source of water or negotiate compensation with the property owner.	Pre-construction, construction and operation.	
Minimise socioeconomic impacts during construction and operation.	SE1	On-going consultation with potentially affected community and businesses will occur prior to and during construction to address concerns and issues and to identify any adaptive management requirements where feasible and reasonable.	Pre-construction.	Community Involvement and Communications, Draft: A resource manual for staff June 2008.

Outcome	Ref. number	Key action	Timing	Reference document
	SE2	Adequate signage will be implemented during construction and operation to ensure businesses and their patrons are aware of new access routes and/or potential disruptions.	Construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.
	SE3	Occupation and use of compounds and work sites will minimise disturbance to adjacent residents by managing, and minimising where possible: the movement of vehicles, particularly outside of standard working hours; providing temporary noise attenuation (eg, shielding) if practicable; and providing screening to minimise visual intrusion.		<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
	SE4	Traffic management procedures to minimise disruption.	Construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.
	SE5	Adopt a construction environmental management plan to minimise amenity impact.	Construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
	SE6	Management of acid sulfate soils to minimise impacts on priority oyster aquaculture areas.	Construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>

Outcome	Ref. number	Key action	Timing	Reference document
Surface and groundwater				
Minimise water quality impacts.	SGWI	Bunded areas will be used for storage of oils, chemicals, toxic substances and combustible liquids, and for potentially hazardous and contaminating activities (eg washing construction vehicles, plant and equipment, handling and pouring hazardous materials and liquids etc).	Construction.	RTA <i>QA Specification G38 Soil and Water Management (Soil and Water Management Plan).</i> <i>AS 1940 The storage and handling of flammable and combustible liquids.</i> <i>DECC Bunding and Spill Management Guidelines (in DECC Environment Protection Manual for Authorised Officers).</i> <i>RTA Code of Practice for Water Management 1999.</i>
				<i>Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction.</i> <i>RTA's Guidelines for the Control of Erosion and Sedimentation in Roadworks.</i>

Outcome	Ref. number	Key action	Timing	Reference document
	SGW2	Spills will be contained immediately and will be stored in bunded areas until disposal. Spills will be disposed of at a facility that is licensed to receive the waste, or may be disposed of after appropriate treatment.	Construction.	RTA <i>QA Specification G38 Soil and Water Management (Soil and Water Management Plan)</i>. AS 1940 <i>The storage and handling of flammable and combustible liquids</i>. DECC <i>Bunding and Spill Management Guidelines (in DECC Environment Protection Manual for Authorised Officers)</i>. RTA <i>Code of Practice for Water Management 1999</i>. <i>Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction</i>. RTA's <i>Guidelines for the Control of Erosion and Sedimentation in Roadworks</i>.

Outcome	Ref. number	Key action	Timing	Reference document
	SGW3	Water quality will be monitored upstream and downstream of the Proposal site during construction to determine the effectiveness of mitigation strategies. The monitoring program will be developed in consultation with DECCW.	Pre-construction and construction.	<i>Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction.</i> <i>Managing Urban Stormwater: Soils and Construction, Volume 1.</i> <i>The RTA's Code of Practice for Water Management – Road Development and Management.</i> RTA QA Specification G38 Soil and Water Management (Soil and Water Management Plan).
	SGW4	Specific work method statements for in-stream works will be developed and implemented in consultation with relevant government agencies.	Pre-construction and construction.	<i>Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction.</i> <i>The RTA's Code of Practice for Water Management – Road Development and Management.</i> RTA QA Specification G38 Soil and Water Management (Soil and Water Management Plan).

Outcome	Ref. number	Key action	Timing	Reference document
	SGW5	Sediment and erosion control measures will be implemented during the construction and the post construction rehabilitation process.	Construction and operation.	RTA <i>QA Specification G38 Soil and Water Management (Soil and Water Management Plan)</i> . <i>Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction (DECC, 2008)</i> .
	SGW6	The potential for changes in the groundwater table will be further investigated before any major earthworks (defined as a cut or fill with a depth or height exceeding five metres) are undertaken. Where a potential for change is identified, the significance of the change and any resultant impacts will be determined. Where necessary, measures to manage the changes will be designed and implemented.	Pre-construction and construction.	The RTA's Code of Practice for Water Management – Road Development and Management. RTA QA Specification G38 Soil and Water Management (Soil and Water Management Plan).
	SGW7	Areas of potential acid sulfate soils and actual acid sulfate soils will be confirmed and managed in accordance with standard environmental management measures.	Pre-construction and construction.	<i>Acid Sulfate Soils Manual</i> . RTA <i>QA Specification G38 Soil and Water Management (Soil and Water Management Plan)</i> . <i>Guidelines for the Management of Acid Sulphate materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulfidic Black Ooze</i> .
Minimise impacts to waterways.	SGW8	Design to be sensitive to stream morphology, reduce sour and minimise impacts to vegetation.	Pre-construction and construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.

Outcome	Ref. number	Key action	Timing	Reference document
	SGW9	The detailed design of minor waterway crossing structures will be refined during detailed design to maximise hydraulic performance.	Pre-construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.
Minimise impacts to geomorphology.	SGW10	Measures to mitigate potential impacts on local geomorphology will be investigated during detailed design.	Pre-construction.	All relevant RTA policies, specifications, guidance notes and environmental directions. <i>RTA QA Specification G38 Soil and Water Management (Soil and Water Management Plan).</i>
Maximise water efficiency.	SGW11	A water management plan will be developed to ensure water resources are used in the most efficient manner with a focus on achieving water savings and targeting water recycling and re-use.	Pre-construction and construction.	<i>RTA Specification G38 Soil and Water Management (Soil and Water Management Plan).</i>
Flora and fauna				
Minimise impacts on native vegetation, fauna and their habitats.	F1	Detailed design will minimise the area of native vegetation and habitat to be cleared wherever reasonable and feasible.	Pre-construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
	F2	The limits of clearing and other native vegetation disturbance will be clearly marked on relevant work plans and on site with temporary fencing installed prior to clearing.	Construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i> <i>RTA QA Specification B30 - Clearing, Excavation & Backfill for Bridgeworks.</i> <i>RTA QA Specification R178 – Vegetation.</i>
	F3	Rehabilitation and revegetation will be undertaken in stages and as early as practicable to restore and enhance habitat opportunities.	Construction and operation.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>

Outcome	Ref. number	Key action	Timing	Reference document
	F4	Habitat features and resources for native fauna (such as hollow-bearing trees, hollow logs, nest boxes and bush rocks) impacted by the Proposal will be relocated where feasible and reasonable. Such relocation will be undertaken in a manner to limit damage to existing vegetation and will not occur in high condition remnant vegetation.	Pre-construction and construction.	RTA QA Specification G36 Environmental Protection (Management System).
	F5	Native and locally indigenous plants will be used in the landscaping and disturbed areas will be progressively revegetated.	Construction and operation.	RTA QA Specification G36 Environmental Protection (Management System).
Minimise adverse impacts on aquatic habitat and fish species.	F6	Watercourse crossings will be designed to facilitate fish passage where appropriate and in consultation with relevant government agencies.	Pre-construction.	RTA QA Specification G36 Environmental Protection (Management System). <i>Fishnote: Policy and Guidelines for Fish Friendly Waterway Crossings.</i> <i>Policy and Guidelines for Design and Construction of Bridges, Roads, Causeways, Culverts and Similar Structures.</i> <i>Fish Passage Requirements for Waterway Crossings.</i>
	F7	Water quality control measures will be installed as early as possible in the construction program and will be designed / selected to meet identified receiving water objectives.	Pre-construction.	RTA QA Specification G36 Environmental Protection (Management System). RTA QA Specification G38 Soil and Water Management (Soil and Water Management Plan).

Outcome	Ref. number	Key action	Timing	Reference document
	F8	A weed management strategy would be developed as part of the construction environmental management plan.	Construction and operation.	<i>All relevant RTA policies, specifications, guidance notes and environmental directions.</i>
Manage impacts on threatened plant species where possible.	F9	Threatened plants in proximity to the Proposal that are to be retained will be identified by pre construction surveys and protected during construction through exclusion fencing and education of construction workers through the site induction process.	Pre-construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
	F10	The feasibility of relocating individuals of threatened species to suitable habitat will be investigated.	Pre-construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i> <i>Australian Network for Plant Conservation 2004 guidelines.</i>
	F11	Consideration would be given to constructing artificial frog ponds if appropriate.	Pre-construction and construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
Minimise impacts on native fauna during construction.	F12	A suitably qualified ecologist will undertake preclearance surveys. Searches will include nests and large hollow-bearing trees and target habitats of hollow-dwelling species, koalas and frogs. Fauna species found in pre-clearance surveys will be relocated to suitable habitat as close as possible to the area in which they were found.	Pre-construction and construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
	F13	Where feasible and reasonable, removal of frog habitat along drainage lines will not be undertaken during periods of wet weather.	Construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>

Outcome	Ref. number	Key action	Timing	Reference document
	F14	The construction contractor will maintain contact details for local DECCW officers, WIRES and/or other relevant local wildlife carer groups.	Pre-construction and construction.	RTA QA Specification G36 Environmental Protection (Management System).
	F15	Surveys will be undertaken for threatened bat species by a suitably qualified ecologist to identify any roosting bats prior to the demolition of the existing highway bridges. Any bats will be moved and relocated following consultation with DECCW.	Pre-construction and construction.	RTA QA Specification G36 Environmental Protection (Management System).
	F16	Development of a nest box strategy will be undertaken.	Pre-construction.	RTA QA Specification G36 Environmental Protection (Management System).
Maintain terrestrial fauna connectivity.	~~F16~~ F17	Culverts and bridges identified in the Environmental Assessment as having a potential role in fauna crossing will be designed to facilitate fauna movements where feasible and reasonable.	Pre-construction.	RTA QA Specification G36 Environmental Protection (Management System). RTA QA Specification B30 - Clearing, Excavation & Backfill for Bridgeworks.
	F18	The feasibility of widening the median will be further investigated in consultation with DECCW during the detailed design.	Pre-construction.	RTA QA Specification G36 Environmental Protection (Management System).
Limit opportunities for animals to access the highway.	~~F17~~ F19	Fauna exclusion fencing (eg floppy-top fencing) will be erected along the Proposal at appropriate locations to direct fauna movement towards fauna crossing structures.	Pre-construction.	RTA QA Specification G36 Environmental Protection (Management System).
Offset the residual impacts of the Proposal on key habitat.	~~F18~~ F20	An agreement will be developed in negotiation with Department of Planning and in consultation with DECCW for habitat offsets.	Pre-construction and construction.	RTA QA Specification G36 Environmental Protection (Management System). RTA Compensatory Habitat Policy and Guideline (draft).

Outcome	Ref. number	Key action	Timing	Reference document
Determine effectiveness of flora and fauna mitigation measures.	~~F19~~ F21	A monitoring program will be developed to allow the effectiveness of mitigation and offset measures to be assessed and allow for their modification if necessary. The program will be for a minimum of 12 months after construction completion.	Pre-construction, construction and operation.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i>
Noise and vibration				
<i>Construction noise</i>				
Minimise construction noise and vibration impacts.	CN1	All feasible and reasonable mitigation and management measures to minimise construction noise and vibration at sensitive receivers will be investigated. Noise and vibration will be monitored to measure against predicted levels. Where required, feasible and reasonable mitigation measures will be implemented.	Pre-construction and construction.	<i>Environmental Noise Management Manual.</i> <i>Interim Construction Noise Guideline (DECC).</i>
	CN2	All reasonable attempts will be made to contact sensitive receivers that will be affected by blasting at least 48 hours prior. Blasting will normally be limited to between 9am and 5pm Monday to Friday and between 9am and 1pm Saturday. No blasting will take place outside these hours without approval from Department of Planning and following consultation with and/or notification of local residents and DECCW.	Construction.	<i>Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration. Community Involvement and Communications, Draft: A resource manual for staff June 2008.</i>

Outcome	Ref. number	Key action	Timing	Reference document
	CN3	Construction will normally be limited to the following hours: - Between 6am and 6pm Monday to Friday. - Between 7am and 4pm Saturday. There would be no works outside these hours, or on Sundays or public holidays, except: - For works that do not cause construction noise to be audible at any sensitive receivers. - For the delivery of materials required outside these hours by the Police or other authorities for safety reasons. - Where work is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm. - For any other work as agreed through negotiations between the RTA and potentially affected sensitive receivers. Any such agreement must be recorded in writing and a copy kept on site for the duration of the works.	Construction.	<i>Interim Construction Noise Guideline (DECC). Community Involvement and Communications, Draft: A resource manual for staff June 2008.</i>

Outcome	Ref. number	Key action	Timing	Reference document
		e) Where the work is identified in the construction noise and vibration management plan and approved as part of the construction environmental management plan. f) As otherwise agreed by the DECCW. Local residents and the DECCW will be informed of the timing and duration of work approved under items (d) and (e) at least 48 hours before that work commences. Hours of work will be addressed in the construction noise and vibration management plan, which will be finalised in consultation with the Department of Planning and the DECCW.		
<i>Operational noise</i>				
Operational noise and vibration managed.	ONI	Where required, reasonable and feasible noise and vibration management measures will be further developed and implemented during detailed design in consultation with relevant property owners.	Pre-construction and construction.	<i>Environmental Criteria for Road Traffic Noise.</i>
Determine effectiveness of operational noise control measures.		Operational noise will be monitored within one year after construction is finished. If monitoring indicates a clear trend that traffic noise levels exceed those predicted, all further feasible and reasonable measure will be investigated. Any additional mitigation measures will be developed in consultation with a suitably qualified and experienced acoustic specialist and the affected property owner.	Operation.	<i>Environmental Noise Management Manual.</i> <i>Environmental Criteria for Road Traffic Noise.</i> <i>Environmental Noise Management Manual.</i>

Outcome	Ref. number	Key action	Timing	Reference document
Visual amenity and design				
Maintained or enhanced Landscape character.	VAD1	A detailed urban and landscape design plan would be developed during the detailed design phase. The detailed design and implementation of built elements (such as new carriageways, bridges and roadside furniture) and landscapes, and the mitigation of residual impacts will be undertaken in accordance with the visual and design objectives and principles of the Proposal.	Pre-construction and construction.	<i>Beyond the Pavement RTA Urban Design Policy, Procedures and Design Principles.</i> <i>RTA Bridge Aesthetics.</i> <i>RTA Landscape Guideline.</i>
Visual impacts are mitigated over the long-term and ongoing maintenance of urban design elements and landscape is minimised.	VAD2	Built elements will be robust, long-lasting, replaceable and easy to maintain materials and designs.	Pre-construction and construction.	<i>Beyond the Pavement RTA Urban Design Policy, Procedures and Design Principles.</i> <i>RTA Bridge Aesthetics.</i> <i>RTA Landscape Guideline.</i>
Minimise the visual impact of the Proposal.	VAD3	The schedule of species to be used in the landscaping treatments will include self-sustaining native and locally indigenous plants that will be selected in consultation with a qualified landscape officer.	Pre-construction and construction.	<i>RTA QA Specification R179 – Landscape Planting.</i> <i>RTA QA Specification R178 – Vegetation.</i>
	VAD4	Disturbed areas will be progressively revegetated with consideration to related controls such as erosion and sedimentation controls, drainage and future road user safety requirements.	Construction and operation.	<i>RTA QA Specification R179 – Landscape Planting.</i> <i>RTA QA Specification R178 – Vegetation.</i>
	VAD5	Design criteria will be applied during detailed design to reduce any potential adverse visual impacts to the existing landscape character and visual amenity.	Pre-construction.	<i>Beyond the Pavement RTA Urban Design Policy, Procedures and Design Principles.</i> <i>RTA Bridge Aesthetics.</i> <i>RTA Landscape Guideline.</i>

Outcome	Ref. number	Key action	Timing	Reference document
Maintenance management and of landscaping.	VAD6	Landscaped or rehabilitated areas will be monitored and maintained for a minimum of two years after opening.	Construction and operation.	RTA <i>QA Specification R179 – Landscape Planting.</i> RTA <i>QA Specification R178 – Vegetation.</i>
Traffic and transport				
Resolution of damage to roads as a result of construction.	T1	Pre-construction dilapidation reports will be prepared for all non-arterial roads likely to be used by construction traffic. Copies of the reports will be provided to the relevant roads authority.	Pre-construction.	RTA <i>QA Specification G36 Environmental Protection (Management System).</i> <i>All relevant RTA policies, specifications, guidance notes and environmental directions.</i>
	T2	Post-construction dilapidation reports will be prepared for the roads assessed in T1 above. Copies of the reports will be provided to the relevant roads authority. Any damage resulting from construction, (not normal wear and tear), will be repaired or an alternative arrangement for road damage will be agreed with the relevant roads authority.	Operation.	RTA <i>QA Specification G36 Environmental Protection (Management System).</i> <i>All relevant RTA policies, specifications, guidance notes and environmental directions.</i>
	T3	Construction vehicle movements, work programs and traffic control measures will be planned to avoid or minimise impacts on traffic through the implementation of all feasible and reasonable design, and mitigation and management measures.	Pre-construction construction.	RTA <i>Traffic Control at Work Sites.</i> RTA <i>QA Specification G10 Control of Traffic.</i>
Impacts to waterway users minimised.	T4	The centre spans of the bridges over the Hastings River and the Wilson River will be no lower in height than the existing bridges to ensure navigational clearance is maintained.	Pre-construction.	

Outcome	Ref. number	Key action	Timing	Reference document
Informed residents.	T5	Consultation with those residents whose access will be affected during construction will be undertaken.	Pre-construction construction.	<i>Community Involvement and Communications, Draft: A resource manual for staff June 2008.</i> <i>AS 4269 Complaints Handling.</i>
Safer cycling and pedestrian movement.	T6	Signposting and crossing points will be provided for cyclists at the on and off ramps at interchanges offering a safer cycling and pedestrian environment.	Operation.	All relevant RTA policies, specifications, guidance notes and environmental directions.
Reliable public transport.	T7	Provision will be made to maintain access for the existing bus operation.	Construction.	All relevant RTA policies, specifications, guidance notes and environmental directions.
Aboriginal heritage				
Minimise the impact on Aboriginal heritage.	AH1	An Aboriginal heritage management plan will be developed to document procedures, management measures and protocols to minimise impacts.	Pre-construction and construction.	<i>RTA Procedure for Aboriginal cultural heritage consultation and investigation. Aboriginal cultural heritage: standards and guidelines kit (DECC).</i> <i>Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC).</i>

Outcome	Ref. number	Key action	Timing	Reference document
	AH2	Items and areas of archaeological significance not directly affected will be protected during construction.	Pre-construction and construction.	RTA <i>Procedure for Aboriginal cultural heritage consultation and investigation. Aboriginal cultural heritage: standards and guidelines kit (DECC).</i> <i>Protecting Aboriginal objects and places interim guidelines for community consultation (DECC).</i> <i>National Parks and Wildlife Act 1974.</i>
	AH3	Protocols will be established and implemented should any previously unidentified Aboriginal objects or human skeletal remains be encountered during construction works on the project. All works in the vicinity of the find will cease until Police and Aboriginal heritage specialist advice is obtained and the DECCW.	Construction.	RTA <i>Procedure for Aboriginal cultural heritage consultation and investigation. National Parks and Wildlife Act 1974.</i> <i>Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC).</i>
	AH4	Any Aboriginal heritage items directly affected will be managed in consultation with Aboriginal stakeholders and the DECCW.	Pre-construction and construction.	RTA <i>Procedure for Aboriginal cultural heritage consultation and investigation. National Parks and Wildlife Act 1974.</i> <i>Protecting Aboriginal objects and places - interim guidelines for community consultation (DECC).</i>

Outcome	Ref. number	Key action	Timing	Reference document
	AH5	All construction personnel will receive Aboriginal heritage awareness training on their obligations for protection of Aboriginal cultural materials, including information on site locations, conservation management requirements and legal obligations in regard to Aboriginal cultural materials.	Pre-construction.	RTA <i>Procedure for Aboriginal cultural heritage consultation and investigation. National Parks and Wildlife Act 1974.</i>
Ensuring on-going Aboriginal participation.	AH6	The RTA will comply with the NSW Government's Aboriginal Participation in Construction Guidelines.	Pre-construction and construction.	RTA <i>Procedure for Aboriginal cultural heritage consultation and investigation.</i> NSW Government's <i>Aboriginal Participation in Construction Guidelines (2007).</i>
	AH7	The RTA will consult with the Birpai Local Aboriginal Land Council regarding management of any potential adverse impacts on the identified sensitive site in accordance with the aboriginal heritage management plan.	Pre-construction and construction.	RTA <i>Procedure for Aboriginal cultural heritage consultation and investigation.</i> NSW Government's <i>Aboriginal Participation in Construction Guidelines (2007).</i>
Air quality				
	AQ1	Feasible and reasonable mitigation measures will be adopted to minimise windblown, traffic-generated or equipment-generated dust and emissions.	Construction.	<i>Protection of the Environment Operations Act 1997.</i> RTA <i>QA Specification G36 Environmental Protection (Management System).</i>
	AQ2	Dust generating activities will stop where visible dust is being emitted outside the construction corridor and when dust suppression methods are ineffective.	Construction.	RTA <i>QA Specification G36 Environmental Protection (Management System).</i>

Outcome	Ref. number	Key action	Timing	Reference document
Climate change and greenhouse gas emissions				
	CG1	Energy efficient work practices will be adopted to limit energy use. Where reasonable and feasible, equipment and management measures will be adopted to minimise energy use and greenhouse gas production. Minimise vegetation clearance where possible.	Pre-construction and construction.	RTA <i>QA Specification G36 Environmental Protection (Management System)</i> .
	CG2	A lighting scheme will be developed during detailed design. The aim of the design will be to minimise the use of lighting.	Pre-construction.	RTA <i>Pacific Highway Design Guidelines</i> .
Non-Aboriginal heritage				
Minimise impacts on non-Aboriginal heritage items.	NAH1	The detailed design will minimise impacts to the identified non-Aboriginal heritage items where feasible and reasonable.	Pre-construction.	<i>Heritage Act 1977</i> . RTA <i>QA Specification G36 Environmental Protection (Management System)</i> .
	~~NAH4~~ NAH2	A non-Aboriginal heritage management plan will be developed.	Pre-construction.	<i>Heritage Act 1977</i> . RTA <i>QA Specification G36 Environmental Protection (Management System)</i> .
	NAH3	Staff will receive training with respect to identifying items of non-Aboriginal heritage during construction and the correct methods of communication on the worksite.	Construction.	<i>Heritage Act 1977</i> . RTA <i>QA Specification G36 Environmental Protection (Management System)</i> .
	~~NAH2~~ NAH4	If any material of potential archaeological significance is unearthed, work will cease until specialist heritage advice has been obtained. Should any material of potential archaeological significance be unearthed, the Heritage Branch would be notified.	Pre-construction and construction.	<i>Heritage Act 1977</i> . RTA <i>QA Specification G36 Environmental Protection (Management System)</i> .

Outcome	Ref. number	Key action	Timing	Reference document
Waste minimisation and management				
	WMM1	The 'waste hierarchy' (avoid/reuse/recycle/ resource recovery/disposal) will be maximised during construction; incorporated into work programs, purchase strategies and site inductions; and will be assessed quarterly to identify opportunities for improvement. Recycled materials will be used where feasible.	Construction.	<i>NSW Government's Waste Reduction and Purchasing Policy.</i> <i>Protection of the Environment Operations Act 1997.</i>
	WMM2	Staff to be trained in waste reduction.	Construction.	<i>NSW Government's Waste Reduction and Purchasing Policy.</i> <i>Waste Avoidance and Resource Recovery Act 2001</i> <i>Relevant DECCW Waste management and classification guidelines.</i>
	WMM3	A waste register to be developed during construction.	Construction.	<i>NSW Government's Waste Reduction and Purchasing Policy.</i> <i>Waste Avoidance and Resource Recovery Act 2001</i> <i>Relevant DECCW Waste management and classification guidelines.</i>

Outcome	Ref. number	Key action	Timing	Reference document
	WMM4	Any waste material that is unable to be re-used, reprocessed or recycled will be disposed at a facility approved to receive that type of waste. Waste will be disposed at a facility licensed to accept that classification of waste.	Construction and operation.	<i>NSW Government's Waste Reduction and Purchasing Policy.</i> <i>Waste Avoidance and Resource Recovery Act 2001</i> <i>Relevant DECCW Waste management and classification guidelines.</i>
Contamination				
Manage potential areas of Contaminated material.	CI	Areas of potential contamination identified during preconstruction and construction activities will be further investigated and appropriately managed.	Pre-construction and construction.	<i>Relevant DECCW Waste management and classification guidelines.</i> <i>RTA Contaminated Land Management Guideline.</i> <i>DECCW Guidelines for NSW Site Auditor Scheme.</i> <i>Contaminated Land Management Act 1997.</i>

Outcome	Ref. number	Key action	Timing	Reference document
Geology and soils				
Erosion and sedimentation minimised.	GS1	Erosion and sedimentation management and control measures will be designed and installed with the advice of a soil conservationist. Controls will be inspected regularly, maintained and managed to maximise their effectiveness.	Pre-construction and construction.	RTA <i>Erosion and Sedimentation Risk Assessment Procedure 2004.</i> RTA <i>QA Specification G38 Soil and Water Management (Soil and Water Management Plan).</i> <i>Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction (DECC, 2008).</i> RTA <i>QA Specification 40 Clearing and Grubbing.</i> RTA <i>QA Specification R178 Vegetation.</i> RTA <i>Stockpile Management Procedures 2001.</i>
	GS2	Acid Sulphate Soil Management Plan will be developed to outline strategies that will be implemented to manage potential impacts of development works that are likely to disturb acid sulfate soils.	Construction.	<i>Acid Sulfate Soils Manual.</i> RTA <i>Guidelines for the Management of Acid Sulphate materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulfidic Black Ooze.</i>
Confirm ground conditions.	GS3	Geotechnical investigations will be undertaken as part of the detailed design phase to confirm preliminary geotechnical investigative works.	Pre-construction.	<i>All relevant RTA policies, specifications, guidance notes and environmental directions.</i>

Outcome	Ref. number	Key action	Timing	Reference document
	GS4	Geomorphologic investigations will be undertaken during the detailed design phase to determine bank and riverbed stability.	Pre-construction.	<i>All relevant RTA policies, specifications, guidance notes and environmental directions.</i>
Manage construction spoil.	GS5	A spoil management strategy will be identifying opportunities for re-using the material onsite and locations outside the Proposal for re-use or disposal. Re-use onsite will be the priority.	Pre-construction.	<i>All relevant RTA policies, specifications, guidance notes and environmental directions.</i>
Minimise potential adverse impacts to banks.	GS6	Detailed design of cut slopes and embankments will be undertaken to ensure there will be minimal long term adverse impacts to banks.	Pre-construction.	<i>RTA guidelines R44 Earthworks.</i>
Utility services				
Minimise disruption to utilities and services.	US1	Utilities and services potentially affected by construction will be identified and requirements for their diversion, protection and / or support identified. Alterations to services will be determined in negotiation with the service providers and will ensure that disruption to services resulting from the project are limited and advised to customers.	Pre-construction and construction.	<i>RTA QA Specification G36 Environmental Protection (Management System).</i> <i>RTA QA Specification G35 Environmental Protection (Management Plan).</i>

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Appendix A

Revised Table 6-2 from Flora and Fauna Working Paper

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Revised Table 6-2 Details of proposed fauna crossings

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
4	1020	Combined	Replace existing with single cell 3m x 3m box culvert. 0.5m flow height at max event. Therefore steps to account for terrestrial fauna together with enough flow to account for fish-friendly crossing can be accommodated by restricting the channel width to 1m.	3.0	3.0	52.8	Links mapped key habitat to the west and habitat to the east contiguous with vegetation in proximate subregional east-west corridor	Koala	Macropods, small mammals, reptiles and amphibians
6	1590	Incidental	Four 1.8 metres x 1.2m box culverts	1.2	1.8	60	Links native vegetation east and west, located in a mapped subregional corridor	No target species	Frogs reptiles Small mammals, if dry
6F	1620	Dedicated	Stand-alone fauna crossing. Sized at 2.4 metres x 3.0 metres. 50m length, would require a skylight. Entry-Exit re-grade works to prevent water entry into the fauna crossing.	3.0	3.0	45.6	Located within a mapped sub-regional corridor linking areas of key habitat to the east and west	Koala	Macropods, possums, small mammals, reptiles and amphibians
9	2605	Incidental	Four 1.8 metres x 1.8 metres box culverts	1.8	1.8	81.6	Not part of a mapped regional corridor	No target species	Frogs reptiles Small mammals, if dry
9F	2625	Dedicated	3m (w) x 2.7 metres (h) stand-alone fauna crossing	1.8	3.0	69.6	Not located within mapped regional or sub-regional corridor; mapped key habitat to the west and habitat to the east	Koala	Small to medium-sized mammals, reptiles and amphibians
10	3585	Incidental	Four 1.5m x 1.2m box culverts	1.2	1.5	46.8	Links native vegetation east and west, not part of a mapped regional corridor	No target species	Frogs Reptiles Small mammals if dry

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
10F	3605	Dedicated	Single cell 3m x 2.1m box culvert	2.1	3.0	43.2	Not located within a mapped regional or sub-regional corridor; mapped key habitat to the west and habitat to the east	Koala	Small to medium-sized mammals, reptiles and amphibians
12	4231	Incidental	One 1.2m x 1.2m RCP	1.2 dia		69.6	Links native vegetation east and west, not part of a mapped regional corridor	No target species	Small mammals if dry Frogs reptiles
13	4456	Combined	Existing 3m(w) x 2.1m(h) box culvert. Extend to the west.	2.1	3.0	69.6	Links native vegetation east and west, not part of a mapped regional corridor	Koala	Small macropods, possums, small mammals, frogs and reptiles
15	4600-4900	Bridge	Fernbank Creek Bridge 104m long, 6 spans				Not part of a mapped regional corridor; patchy vegetation connectivity within riparian corridor to the east and west of proposed crossing	No target species	Koala Possums and macropods, wetland and open country birds, reptiles and amphibians
16	5180	Combined	3m x 2.1m box culvert x 4 cells	2.1	3.0	55	Not part of a regional corridor; floodplain	No target species	Macropods, frogs, reptiles depending on grazing levels
19	5540 and 6020	Bridge	Hastings River Bridge 468m long, 17 spans				Not part of a mapped regional corridor; patchy vegetation connectivity within riparian corridor to the east and west of proposed crossing	No target species	Koala Possums and macropods, wetland and open country birds, reptiles and amphibians
20	6283	Combined	3m x 3m single box culvert	3.0	3.0	50.4	Not part of a mapped regional corridor; floodplain	No target species	Macropods, frogs, reptiles depending on grazing levels

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
21	6727	Combined	3m x 2.4 metres single box culvert	2.4	3.0	40.8	Links vegetation east and west. Not part of a mapped regional corridor.	No target species	Koala and spotted-tailed quoll, possums, smaller macropods, small mammals, reptiles and amphibians
22	7272	Combined	3m x 2.4 metres single box culvert	2.4	3.0	43.2	Not part of a mapped regional corridor. Links vegetation to the east and west contiguous with State forest	Koala	Spotted-tailed quoll, possums, smaller macropods, small mammals, reptiles and amphibians
29	9209	Combined	Re-grade to allow for 3m x 3m fauna crossing. Look at dry crossings. No fish passage required.	3.0	3.0	52.8	Mapped regional corridor associated with key habitat in Rawdon Creek Nature Reserve to the west and key habitat in Cairncross State Forest to the east	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians (possibly green-thighed frog)
32	10680	Incidental	One 1.2m x 0.9m box culvert	0.9	1.2	43.2	Links native vegetation east and west within Cairncross State Forest, vegetation contiguous with mapped regional corridors located to the north and south	No target species	Frogs and some reptiles (dependent on flows and velocities etc) Small mammals, if dry
32A	11151	Incidental	Proposed 3m(w) x 2.4 metres(h) fauna crossing	2.4	3.0	43.2	Links native vegetation east and west within Cairncross State Forest, vegetation contiguous with mapped regional corridors located to the north and south	No target species	Frogs possibly Green-thighed frog reptiles Koala, spotted-tailed quoll and other small mammals possible if dry

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
32B	11692	Incidental	3m x 2.4 metres single box culvert	2.4	3.0	48.0	Located within mapped regional corridor, links vegetation in Cairncross State Forest to the east and west	No target species	Frogs possibly Green-thighed frog Reptiles other small to medium-sized mammals possible if dry
34	12410	Incidental	Single cell 1.8 metres x 0.60 box culvert	0.6	1.8		Not part of a mapped regional corridor	No target species	Frogs, reptiles
40	16050	Bridge	Wilson River Bridge 559.7m long, 15 spans				Not part of a mapped regional corridor; narrow band of generally continuous vegetation within riparian corridor to the east and west of proposed crossing	No target species	Koala Small (dasyurids, rodents), medium (possums) and larger mammals (wallabies and macropods), birds, reptiles and amphibians
44	17175	Bridge	36m long, 3 spans				Not part of a mapped regional corridor	No target species	Koala Small-large mammals (including macropods) birds, reptiles and amphibians
50	17158	Combined	3m x 3m single cell box culvert	3.0	3.0	105.6	Not part of a mapped regional corridor	No target species	Koala, macropods Reptiles and frogs
51	17708	Multiuse crossing (livestock, vehicles, fauna)	Approx 4.5m (w) x 4.5m (w) to account for farm equipment	3.6	3.6	57.6	Not part of a mapped regional corridor network; fragmented vegetation to the east and west	No target species	Koala, macropods, small mammals, birds, reptiles and amphibians

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
52	18623	Incidental	One 3m x 0.9m box culvert	0.9	3.0	48.0	Links fragmented vegetation east and west, not part of a mapped regional corridor	No target species	Frogs Reptiles Small mammals, if dry
53	18743	Incidental	Replace existing with 3m (w) x 2.1m (h) box culvert	2.1	3.0	50.4	Not part of a mapped regional corridor	No target species	Frogs Reptiles Small mammals, if dry
57	19660-19710	Bridge	Cooperabung Creek Bridge 32m long, 4 spans				Not part of a mapped regional corridor; riparian vegetation continuous within riparian corridor to the east and west of proposed crossing	No target species	Koala Small , medium and larger mammals (wallabies and macropods), birds, reptiles and amphibians
58S	20050	Incidental	One 1.2m x 1.2m RCP	1.2 dia		28.8	Not part of a mapped regional corridor	No target species	frogs and reptiles
59	20260	Incidental	Replace existing 2.1m RCP with 3m (w) x 2.4 metres (h) box culvert	2.4	3.0	43.2	Links native vegetation east and west adjacent to Cooperabung Nature Reserve, not part of a mapped regional corridor	No target species	frogs and reptiles small mammals possible if dry
60F	20528	Dedicated	Single cell 3m (w) x 3m (h) box culvert	3.0	3.0	55.2	Not part of a regional corridor. Links vegetation to the east and west that is contiguous with a mapped regional corridor in Cooperabung Nature Reserve and Ballengarra State Forest	Koala	Spotted-tailed quoll, macropods Small mammals, reptiles and amphibians

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
63F	21255	Dedicated	Single cell 3m (w) x 3m (h) box culvert	3.0	3.0	84.0	Located in a mapped regional corridor linking mapped key habitat in Cooperabung Nature Reserve and Ballengarra State Forest	Koala	Macropods, spotted-tailed quoll Small mammals, reptiles and amphibians
64	21531	Combined	3m x 3m fauna crossing. Median is wide and therefore would need an opening for light. Existing 1200 mm RCP to be replaced	3.0	3.0	64.8	Located in a mapped regional corridor linking areas of key habitat to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians
65	21791	Combined	Replace existing with 3m (w) x 3m (h) box culvert to be installed. Look at open median with treatment	3.0	3.0	60.0	Located in a mapped regional corridor linking areas of key habitat to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians
66	22179	Combined	Existing 2 x 2.7 metres dia steel pipes to be replaced with single 3.6m (h) x 3.6m (h) box culvert	3.6	3.6	76.8	Located in a mapped regional corridor linking areas of key habitat to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians
67F	23325	Dedicated	Single cell 3m (w) x 3m (h) box culvert	3.0	3.0	48.0	Located in a mapped regional corridor linking areas of key habitat to the east and west; vegetation contiguous with mapped climate change corridor to the east	Koala	Possums, spotted-tailed quoll, macropods Small mammals, reptiles and amphibians
71	23140	Incidental	Single 900mm dia RCP. To be replaced with 3m (w) x 2.1m (h)	2.1	3.0	55.2	Located in a mapped regional corridor linking areas of key habitat to the east and west; vegetation contiguous with mapped climate change corridor to the east	No target species	Frogs and reptiles Smaller mammals if dry

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
73	23967	Combined	5 x 3m x 3m box culvert to be extended to the east. Median opening required	3.0	3.0	31.2	Located in a mapped regional corridor linking areas of key habitat to the east and west; vegetation contiguous with mapped climate change corridor to the east	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians
74	24441	Incidental	Replace existing 1500mm dia RCP with single 3m (w) x 1.8 metres (h) box culvert	1.8	3.0	45.6	Located in a mapped regional corridor linking areas of key habitat to the east and west; vegetation contiguous with mapped climate change corridor to the east	No target species	Frogs and reptiles Small to medium mammals possibly if dry
75	24732	Incidental	Replace existing with single 3m (w) x 2.4 metres (h) box culvert	2.4	3.0	62.4	Located in a mapped regional corridor linking areas of key habitat to the east and west; vegetation contiguous with mapped climate change corridor to the east	No target species	frogs and reptiles Small to medium mammals possibly if dry
76	25105	Incidental	Extend existing 1500mm dia RCP	1.5 dia		30.0	Located in a mapped regional corridor linking areas of key habitat to the east and west; vegetation contiguous with mapped climate change corridor to the east	No target species	frogs and reptiles Small to medium mammals possibly, if dry
78	25427	Incidental	Replace existing 1500mm dia RCP with 3m (w) x 1.5m (h) box culvert	1.5	3.0	45.6	Located on northern edge of mapped regional corridor; links vegetation to the east and west	No target species	frogs and reptiles Small to medium mammals possibly, if dry

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
80	25706	Combined	Replace existing 1800mm with single cell 3m x 2.7 box culvert	2.7	3.0		Not part of a mapped regional corridor; links vegetation to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians
83	26383	Incidental	Existing 1800mm RCP to be replaced with 1500mm dia RCP	1.5 dia		26.4	Not part of a mapped regional corridor; links vegetation to the east and west	No target species	Frogs and reptiles Small to medium mammals possibly, if dry
83F	26400	Dedicated	Single cell 3m (w) x 3m (h) box culvert	3.0	3.0	40.8	Not part of a mapped regional corridor; links vegetated habitat east and west	Koala	Macropods, spotted-tailed quoll Small mammals, reptiles and amphibians
84	26785	Combined	Existing 1200 mm dia RCP to be replaced with 3m (w) x 3m (w) box culvert	3.0	3.0	45.6	Not part of mapped regional corridor network; limited connectivity to the west	Koala	Macropods, spotted-tailed quoll Small mammals, reptiles and amphibians
86	27510	Combined	Replace existing 1200 mm dia RCP with 3m x 3m box culvert	3.0	3.0	43.2	Located within sub-regional corridor linking extensive areas of mapped key habitat within state forests to the east and west	Koala	Macropods, spotted-tailed quoll Small mammals, reptiles and amphibians
88	28225-28270	Bridge	Smiths Creek Bridge 30m long, 3 spans				Located on edge of subregional corridor; riparian vegetation continuous within riparian corridor to the east and west of proposed crossing	No target species	Koala, spotted-tailed quoll Small , medium and larger mammals (wallabies and macropods), birds, reptiles and amphibians

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
88a	28295	Dedicated	Two 3m x 3m box culverts	3.0	3.0	24.0	Located on the edge of a mapped sub-regional corridor linking extensive areas of key habitat within state forests to the east and west	Koala	Macropods, spotted-tailed quoll Small mammals, reptiles and amphibians
89	28673	Combined	Three 2.4 metres x 2.4 metres box culverts	2.4	2.4	28.8	Not part of mapped regional corridor; Links fragmented vegetation to the east and west	No target species	Koala, small mammals and macropods, reptiles and amphibians
90	29608	Incidental	Four 1.5m x 1.5m box culverts	1.5	1.5	21.6	Not part of mapped regional corridor; Links fragmented vegetation to the east and west	No target species	Frogs Reptiles Small mammals possible if dry
91	30077	Incidental	One 3m x 2.7 metres box culvert	2.7	3.0	45.6	Not part of mapped regional corridor; Links fragmented vegetation to the east and west	No target species	Frogs Reptiles Small mammals possible if dry
92	30660	Bridge	Pipers Creek Bridge 31m long, 3 spans				Not part of a mapped regional corridor; riparian vegetation continuous within riparian corridor to the east and west of proposed crossing	No target species	Koala, spotted-tailed quoll Small, medium and larger mammals (wallabies and macropods), birds, reptiles and amphibians
93	30957	Combined	One 3m x 1.5m box culvert				Located near a mapped regional corridor to the north; Links fragmented vegetation to the east and west	No target species	small mammals and macropods, reptiles and amphibians

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
94	31107	Combined	One 3m x 1.8 metres box culvert	1.8	3.0	45.6	Located near a mapped regional corridor to the north; Links fragmented vegetation to the east and west	No target species	small mammals and macropods, reptiles and amphibians
96	31887	Combined	Existing 1050mm dia RCP to be replaced by 3m x 3m box culvert	3.0	3.0	45.6	Located within a mapped regional corridor linking extensive areas key habitat in Maria River and Ballengarra state forests	Koala	Possums, macropods, reptiles and amphibians
97	32357	Combined	Existing 1050mm dia RCP to be replaced by 3m x 3m box culvert	3.0	3.0	43.2	Located within mapped regional corridor linking extensive areas key habitat in Maria River and Ballengarra state forests	Koala	Macropods, small mammals, reptiles and amphibians
98	32662	Combined	Existing 1350mm dia RCP to be replaced by 3m x 3m box culvert	3.0	3.0	40.8	Located within a mapped regional corridor linking extensive areas key habitat in Maria River and Ballengarra state forests	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians
99	33103	Combined	3m x 3m box culvert	3.0	3.0	45.6	Located within a mapped regional corridor linking extensive areas key habitat in Maria River State Forest to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians (green-thighed frog)
100F	33390	Dedicated	3m x 3m single cell box culvert on new carriageways	3.0	3.0	43.2	Located within a mapped regional corridor linking extensive areas of key habitat within Maria River State Forest to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians (green-thighed frog)

Culvert no.	Station	Crossing type	Description	Height	Width	Length	Regional connectivity	Target species	Other species that may use the crossing
102	34086	Combined	3m (w) x 1.8 metres (h) box culvert cut in at western side. Min 1.8 metres (h) required	1.8	3.0	48.0	Located within a mapped regional corridor linking extensive areas key habitat in Maria River State Forest to the east and west		Small-medium macropods, spotted-tailed quoll, possums small mammals, reptiles and amphibians (green-thighed frog)
103	34714	Combined	3m x 2.4 metres single cell box culvert	3.0	3.0	45.6	Located within a mapped regional corridor linking extensive areas key habitat in Maria River State Forest to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians (green-thighed frog)
106	35727	Combined	3m x 3m single cell box culvert	3.0	3.0	40.8	Located within a mapped regional corridor linking extensive areas key habitat in Maria River State Forest to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians (green-thighed frog)
109	36356	Combined	3m x 3m single cell box culvert	3.0	3.0	57.6	Located within a mapped regional corridor linking extensive areas key habitat in Maria River State Forest to the east and west	Koala	Possums, spotted-tailed quoll, macropods, small mammals, reptiles and amphibians (green-thighed frog and possibly giant-barred frog)
N/A	37730-37790	Bridge	Stumpy Creek bridge 36m long, 3 spans				Located within a mapped regional corridor linking extensive areas key habitat in Maria River State Forest to the east and west	No target species	Koala, spotted-tailed quoll, green-thighed frog Small, medium and larger mammals (wallabies and macropods), birds, reptiles and amphibians

Note: These values / dimensions are subject to refinement during detailed design.

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Appendix B

Supplementary Ecology 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) <i>now Department of Environment, Climate Change and Water</i>
DECCW	Department of Environment, Climate Change and Water (NSW) <i>formerly Department of Environment and Climate Change (DECC)</i>
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) <i>now Department of Industry and Investment (NSW)</i>
DII	Department of Industry and Investment (NSW) <i>formerly Department of Primary Industries (DPI)</i>
EEC	Endangered ecological community
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
FM Act	NSW <i>Fisheries Management Act 1994</i>
NPWS	Former National Parks and Wildlife Service <i>now Department of Environment, Climate Change and Water</i>
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) <i>formerly Department of the Environment, Water, Heritage and the Arts</i>
TSC Act	<i>Threatened Species Conservation Act 1995</i>

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 (*Miniopterus 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), Flora 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 Highway¹.

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

1.4 Legislative context

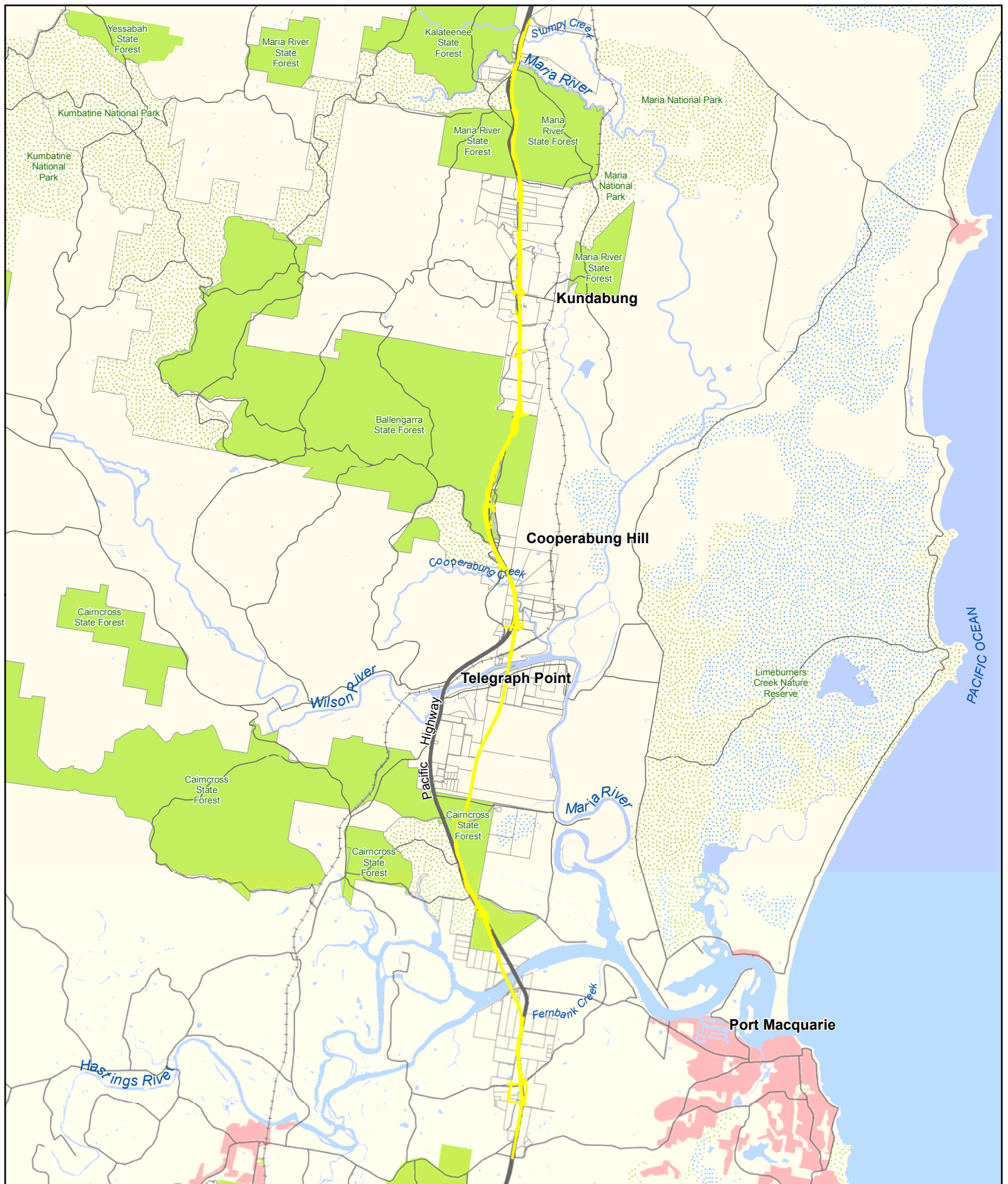
A detailed account of the legislative context is provided in the Working Paper (GHD 2010a). A summary is provided in the following sections.

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).

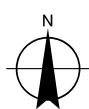
¹ Note that this upstream section of Stumpy Creek occurs within Lot 1 DP 399379



LEGEND

— Roads	■ Built-up urban areas	— Watercourse	— Existing highway
—+— Railway	■ National parks, Nature reserves	■ Wetlands	— Proposal
□ Cadastre	■ State forests	■ Ocean	

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



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 ntmail@ghd.com.au W www.ghd.com.au
 C:\GIS\1205704\Additional Field Survey Maps\O\HK_AFS_001_ProposalLocation_20101110_A_V93.mxd
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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



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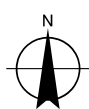
- Study Area
- Cadastre
- Concept Design

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Metres

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



CLIENTS | PEOPLE | PERFORMANCE

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 ntmail@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

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 environmental 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.

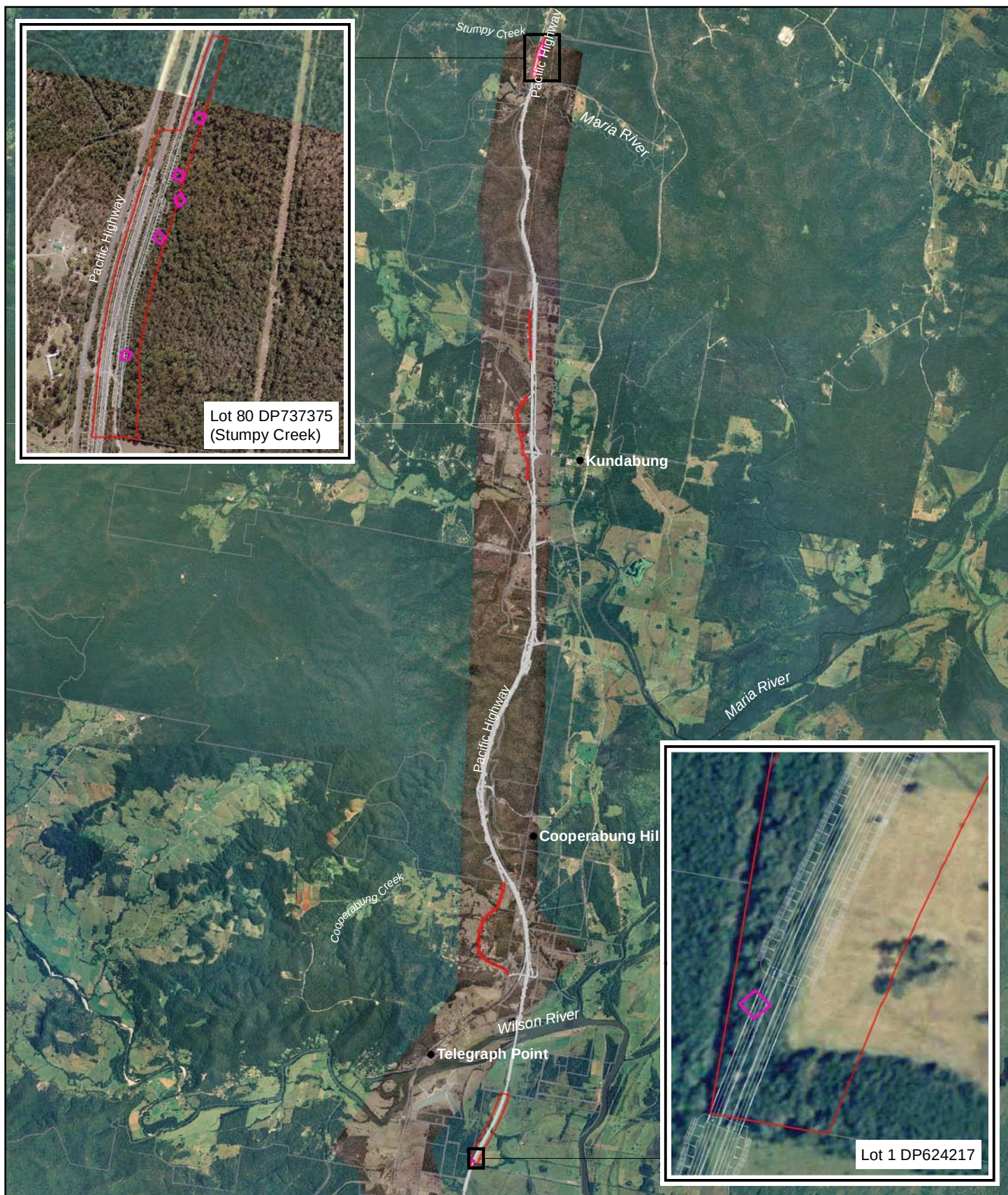
Trapping for arboreal and ground-dwelling mammals

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).

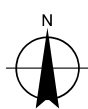
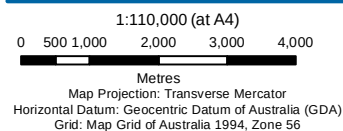
Larger, more difficult species to capture such as the spotted-tailed quoll (*Dasyurus maculatus maculatus*) and long-nosed potoroo (*Potorous tridactylus tridactylis*) were not specifically targeted in the trapping program and have been assessed using habitat and wildlife records.

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



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

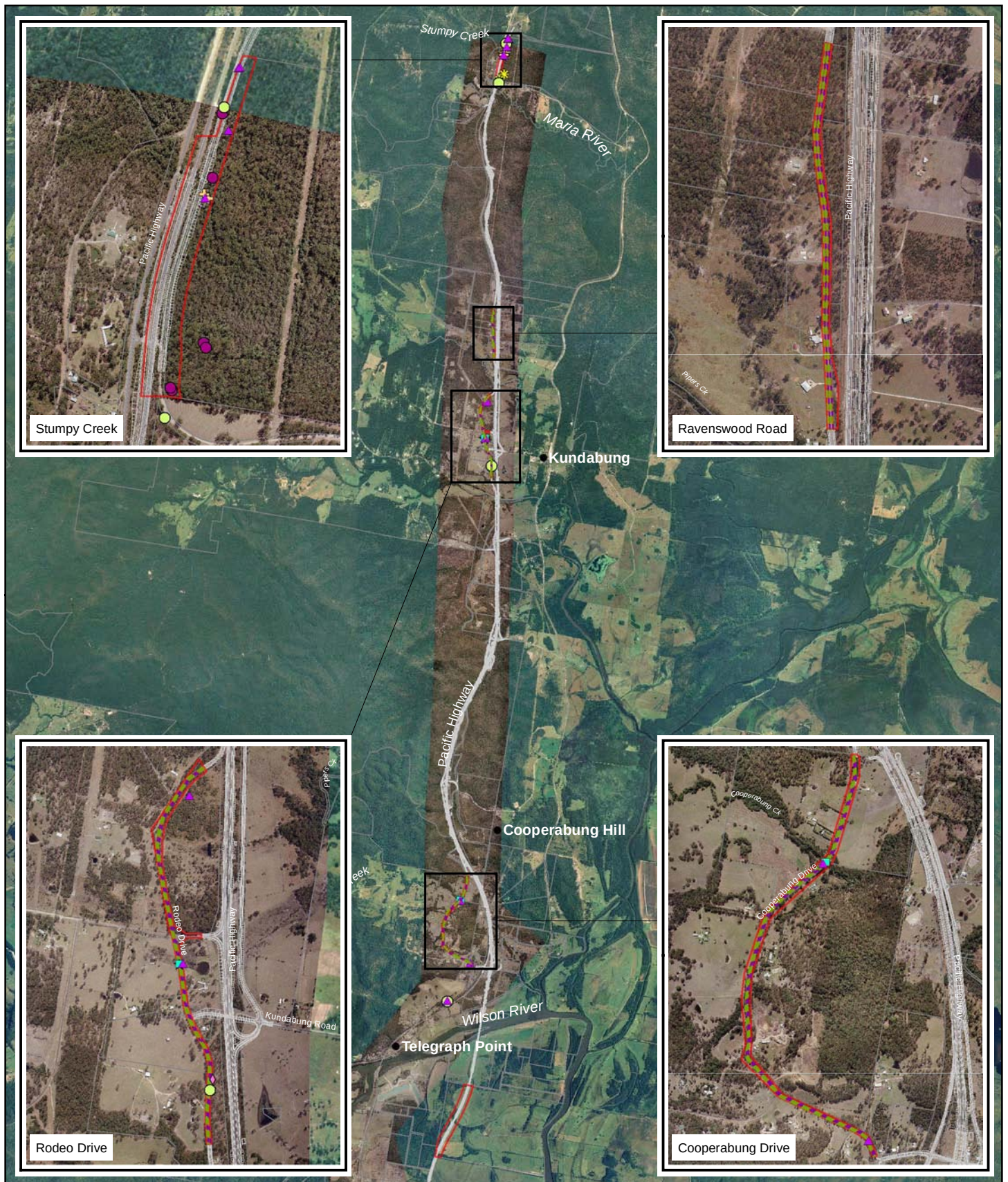


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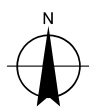
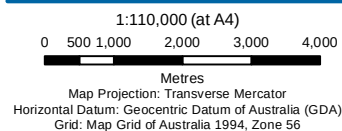
Flora Survey Site Locations

Figure 2.1



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



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Fauna Survey Site Locations

Figure 2.2

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.

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

Elliott 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 Elliott 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 *Allocaeusuarina* 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.

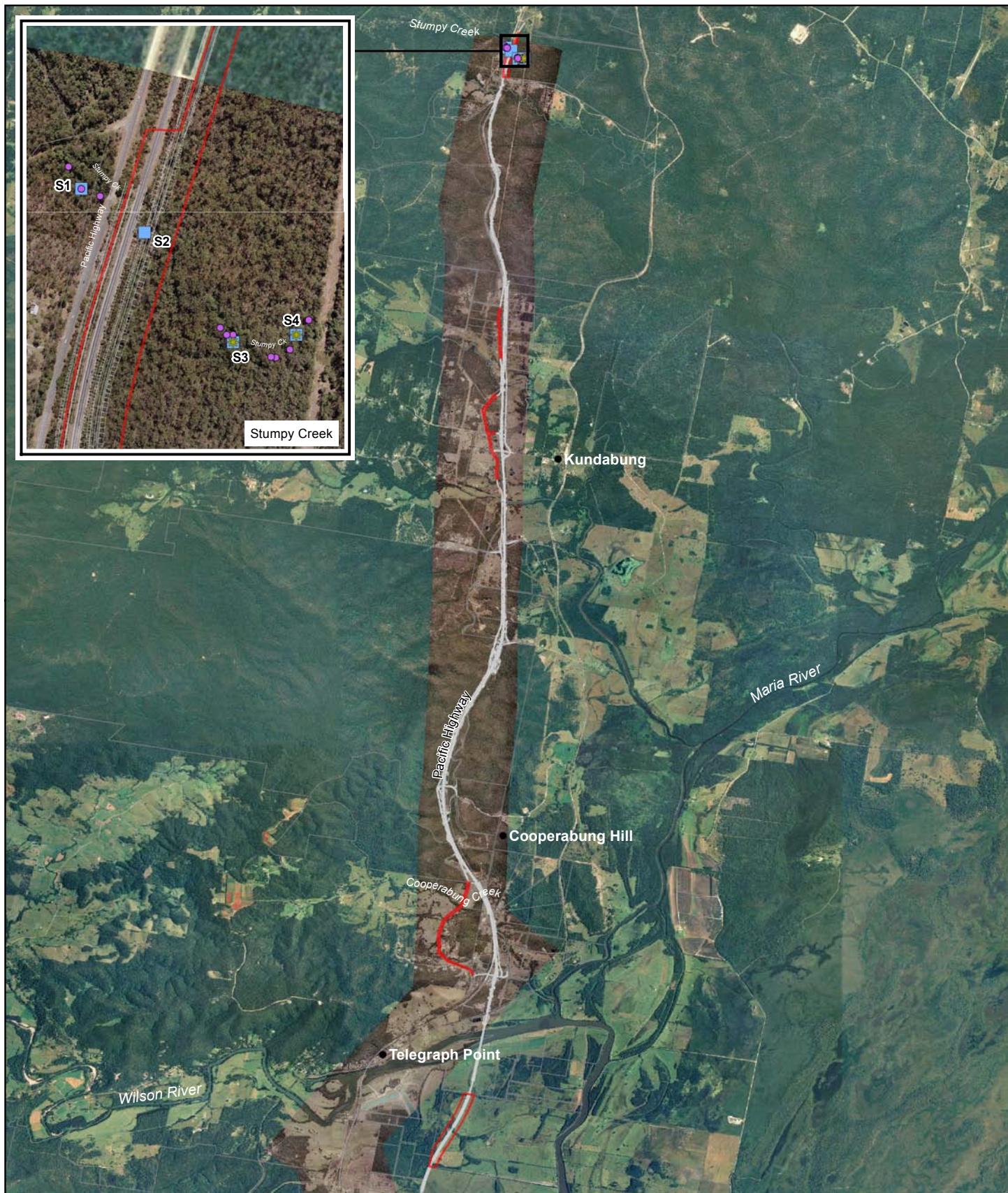
Freshwater wetland areas were difficult to classify using the same criteria and have been given a medium ranking, as while they do provide habitat for a range of species, these areas experience some level of ongoing disturbance due to grazing by cattle.

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**.



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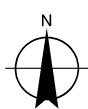
 Study Area	● Bait trap
 Cadastre	✱ Fyke net
 Concept Design	H Habitat Assessment & Water Quality

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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

G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_012_AquaticSurveyLocations_20101110_A_V93.mxd

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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 values 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 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* (tanton). 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 caerulea* (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).

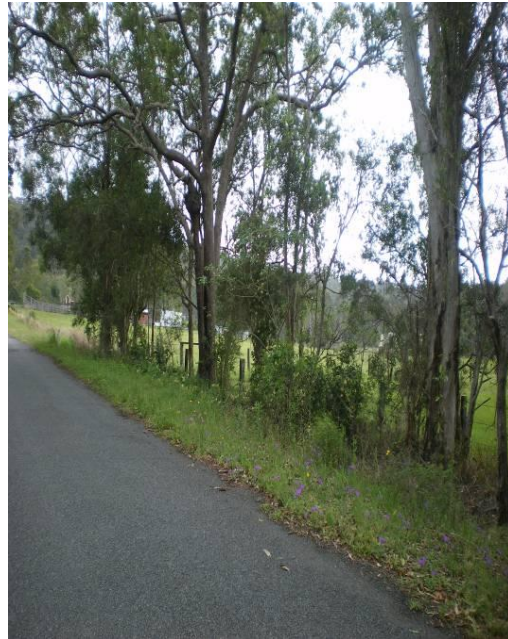


Plate 9 & Plate 10 Dry ridge-top forest of varying quality (Ravenswood Road)

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 bonariensis* (purpletop) and *Paspalum* sp.



Plate 11 Moist floodplain forest (Cooperabung Road)

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

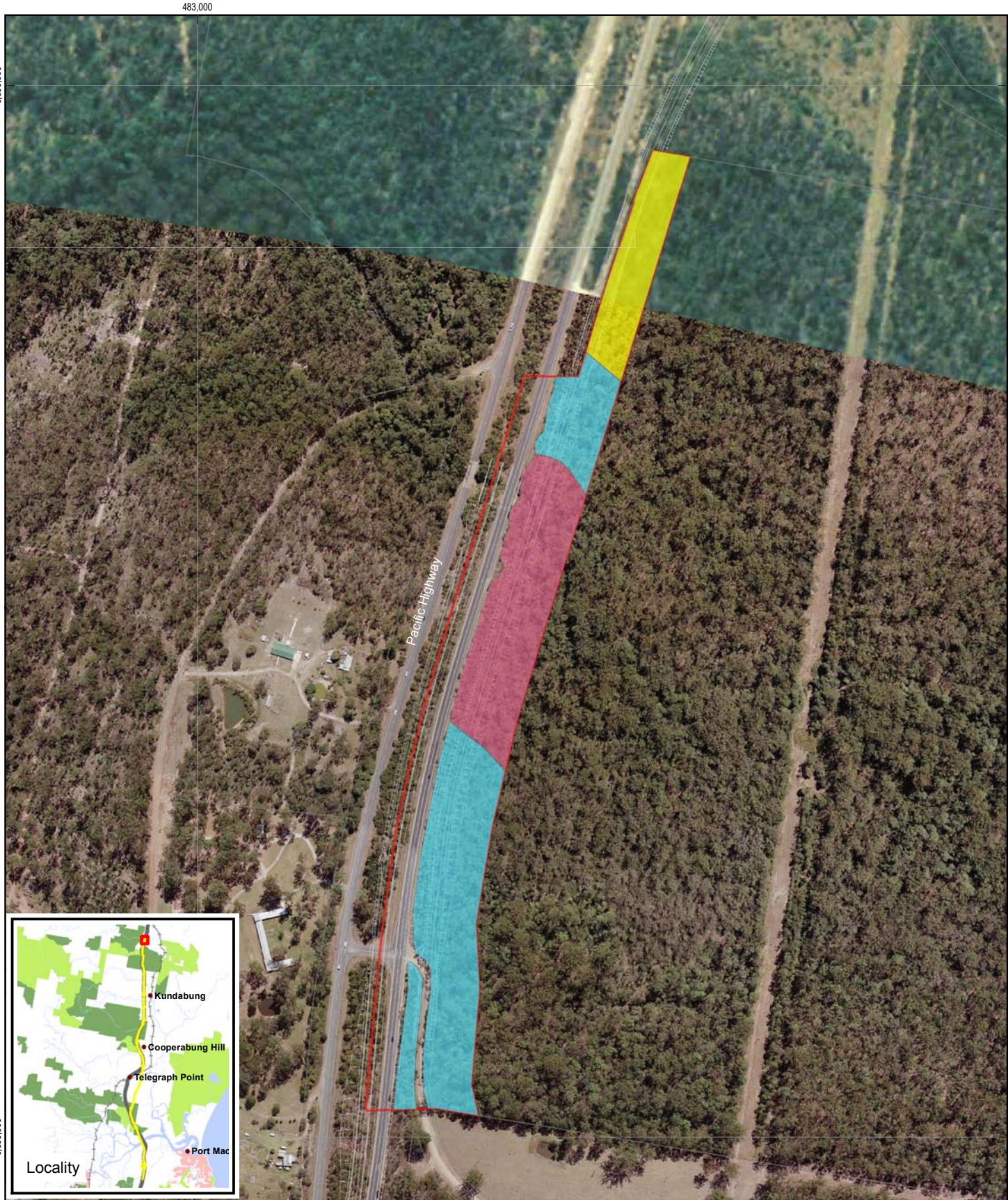
There are numerous areas along each of the service roads that have been cleared of native vegetation and are dominated either entirely by exotic species or have remnant scattered trees over an exotic understorey. Exotic species are most common within roadside drains and location where the road intersects 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

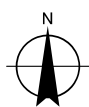
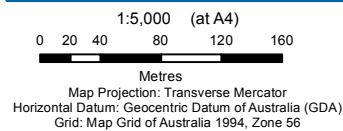


Plate 13 – Scattered trees Ravenswood Road



LEGEND

 Study Area	 Dry Ridgeline Forest
 Cadastre	 Moist Floodplain Forest
 Concept Design	 Moist Gully Forest

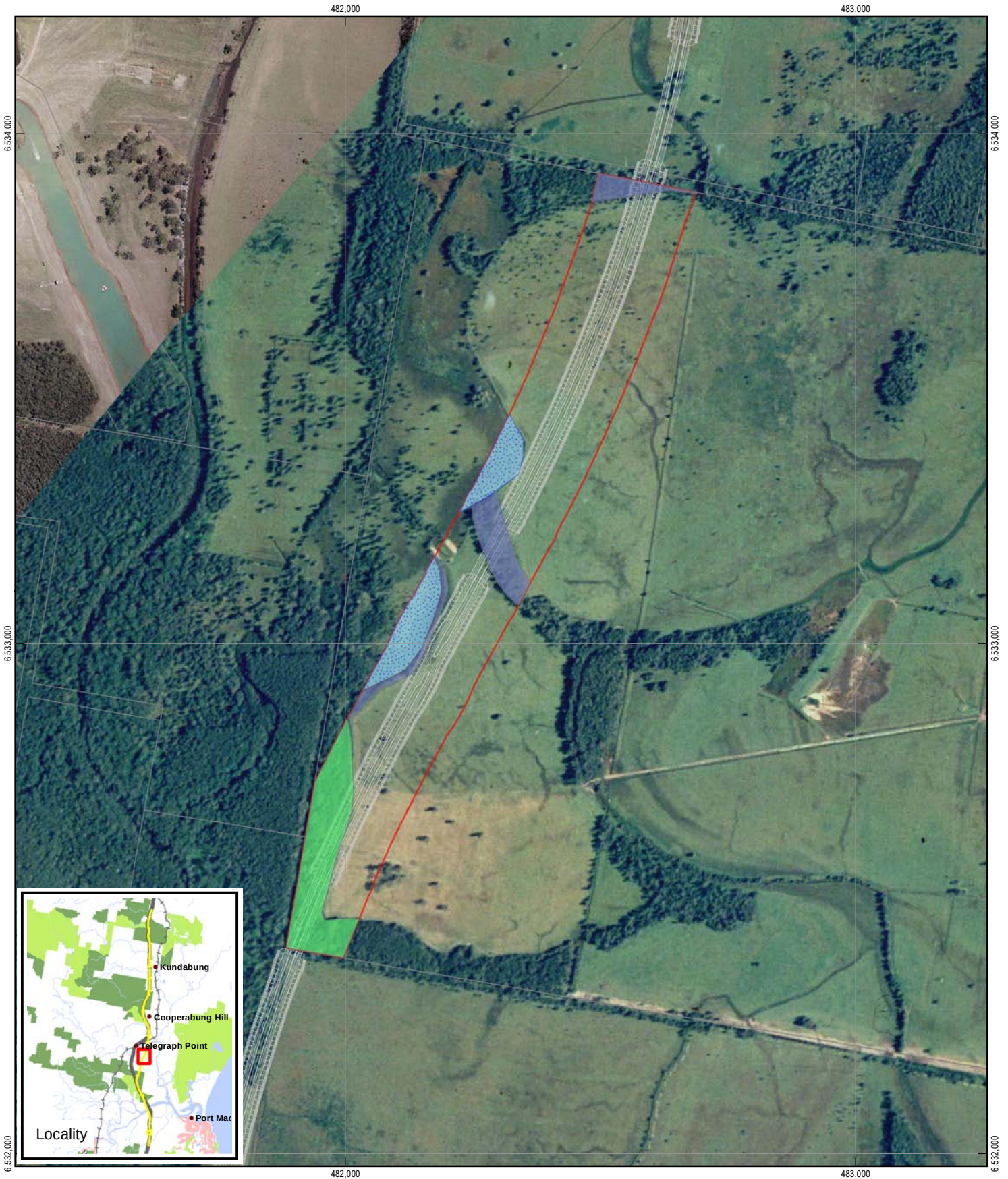


Roads and Traffic Authority
Additional Field Survey

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Date 05 NOV 2010

Lot 80 DP737375 (Stumpy Creek)
Vegetation Mapping

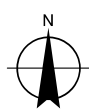
Figure 3.1



LEGEND

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

1:10,000 (at A4)
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 Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia (GDA)
 Grid: Map Grid of Australia 1994, Zone 56



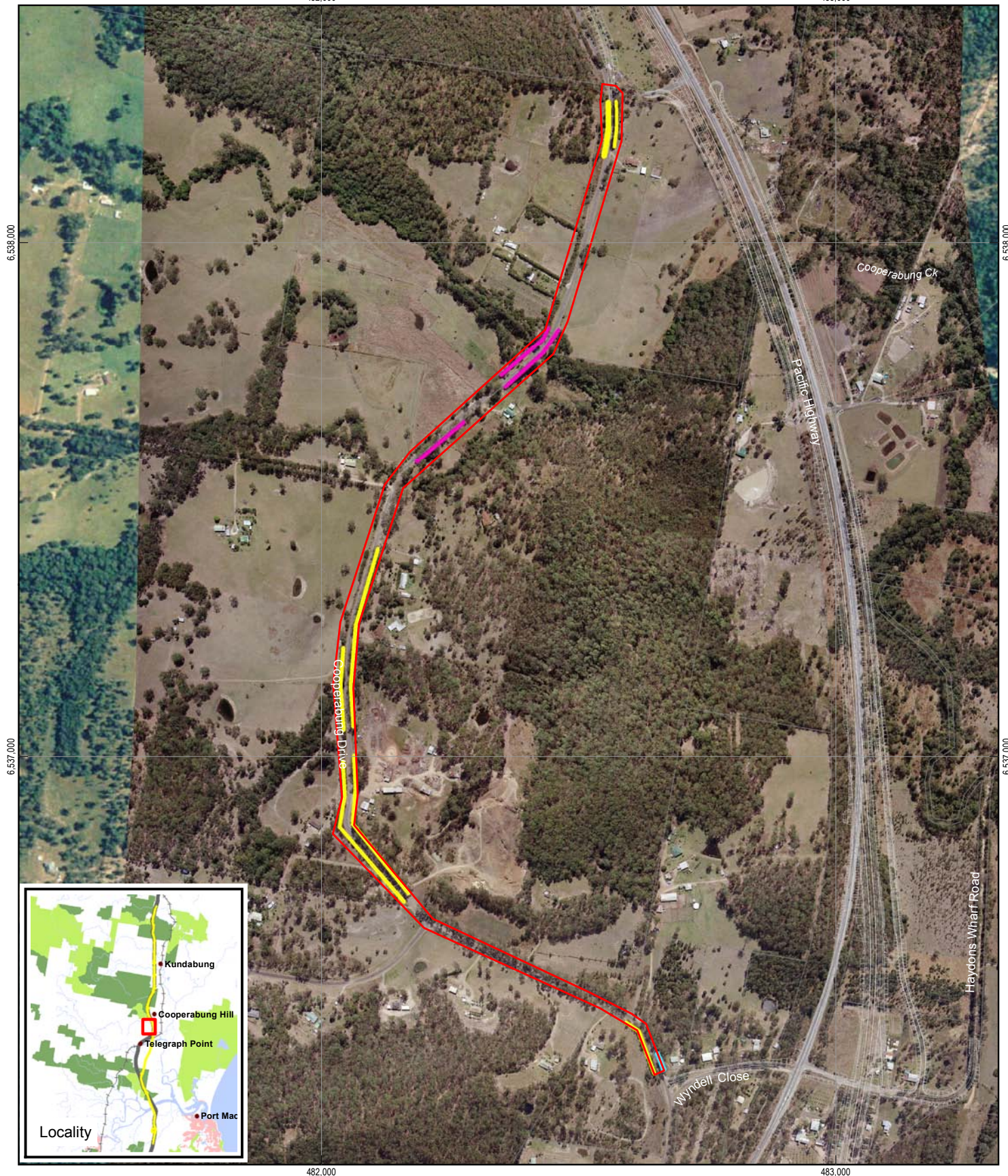
Roads and Traffic Authority
 Additional Field Survey
 Lot 1 DP624217
 Vegetation Mapping

Job Number	22-1374532
Revision	A
Date	25 FEB 2011

Figure 3.2

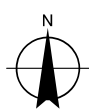
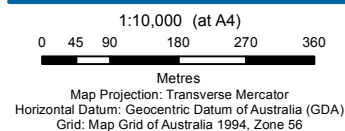
482,000

483,000



LEGEND

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



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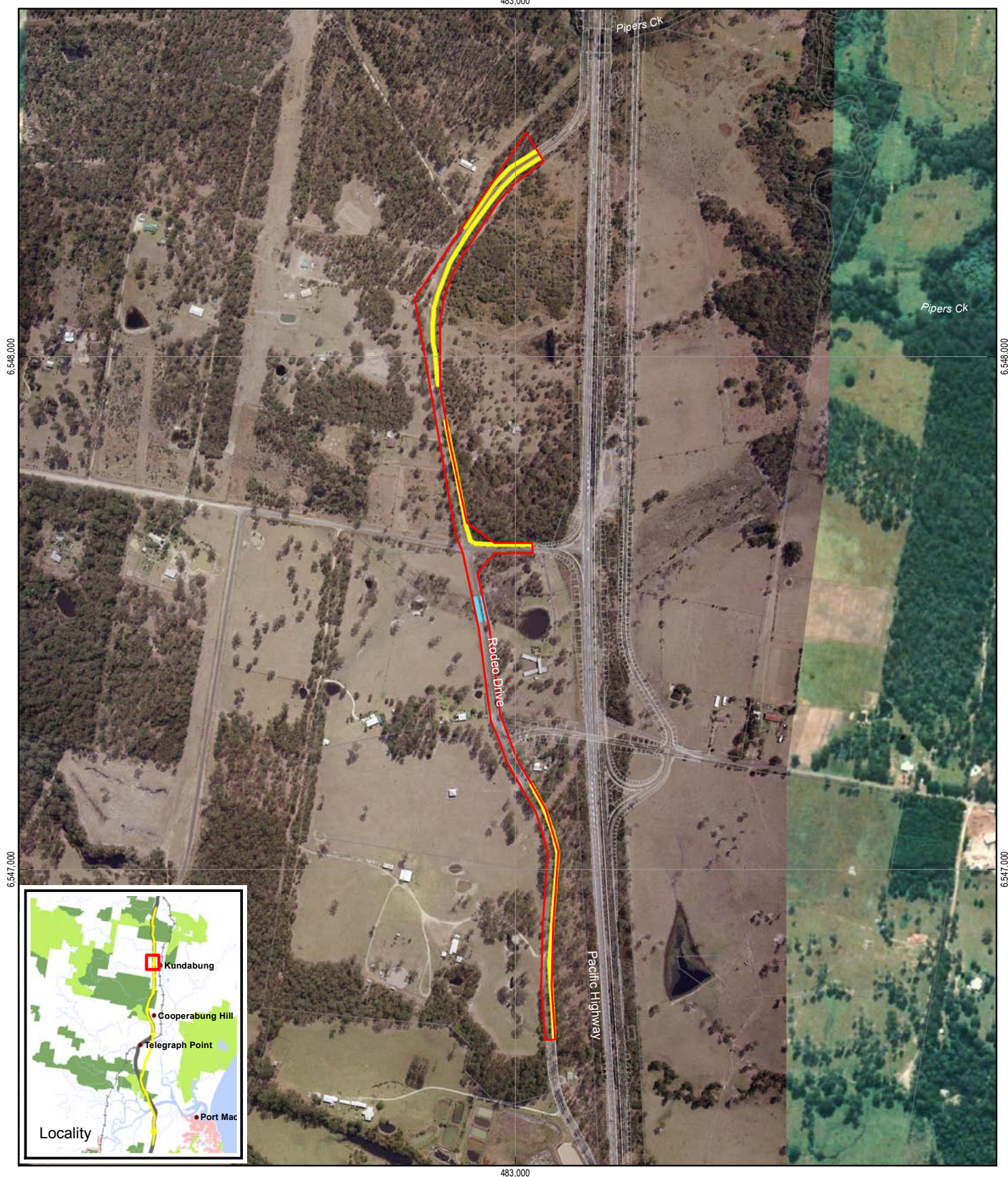
Roads and Traffic Authority
Additional Field Survey

Cooperabung Drive Vegetation Mapping

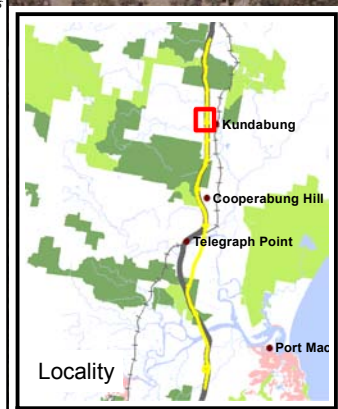
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Figure 3.3

483,000

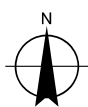
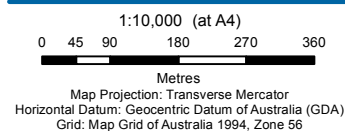


483,000



LEGEND

 Study Area	 Dry Ridgetop Forest
 Cadastre	 Moist Gully Forest
 Concept Design	



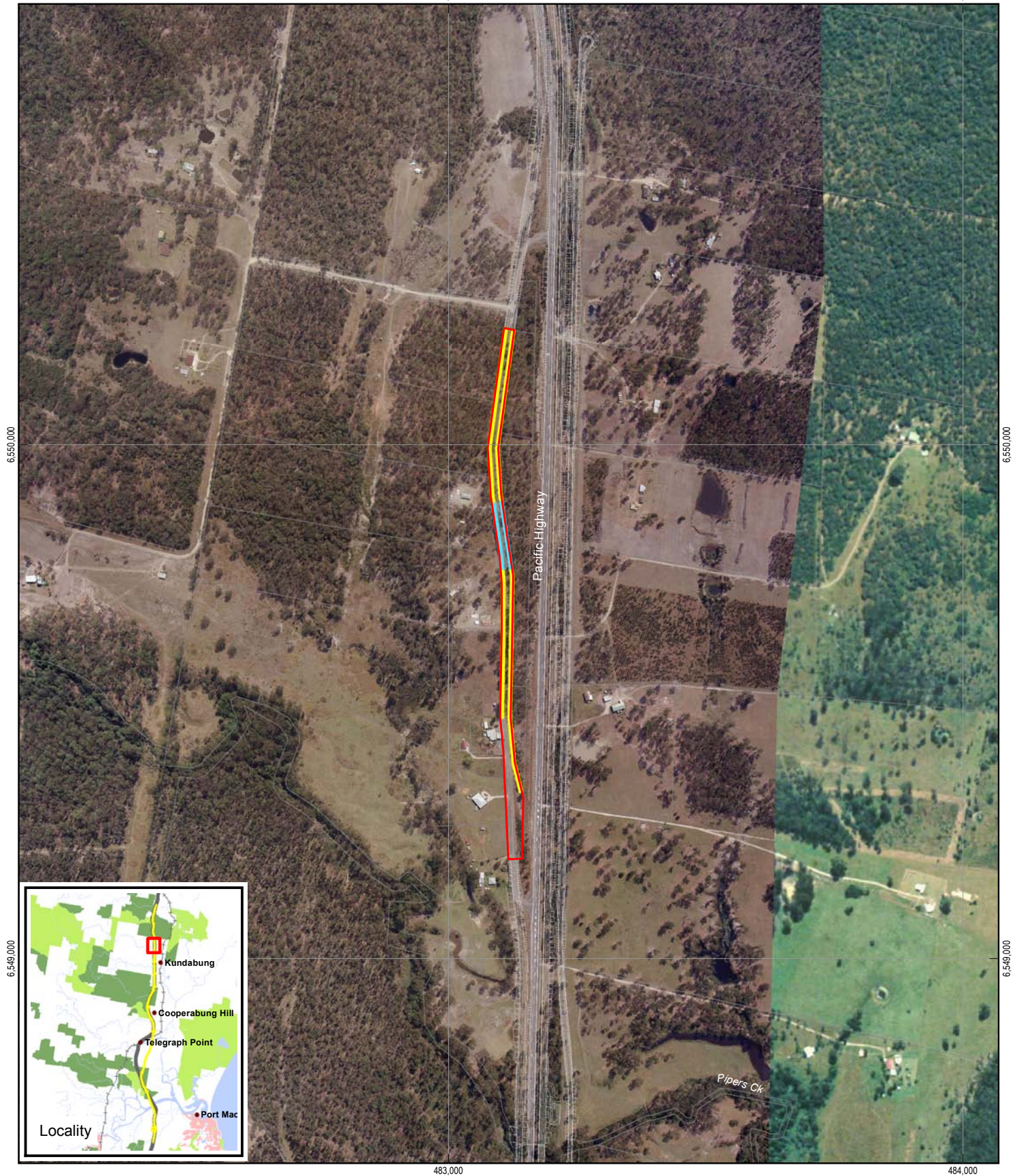
Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 02 DEC 2010

Rodeo Drive Vegetation Mapping

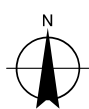
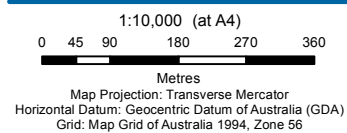
Figure 3.4

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



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Ravenswood Road
Vegetation Mapping

Figure 3.5

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 (<i>Acronychia littoralis</i>)	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 (<i>Acronychia oblongifolia</i>).	Endangered	Endangered
Hairy-joint grass (<i>Arthraxon hispidus</i>)	Recorded within 2 km of the existing highway at Kundabung.	Vulnerable	Vulnerable
Milky silkpod (<i>Parsonsia dorrigoensis</i>)	1 record on the coast near Port Macquarie.	Vulnerable	Endangered
Swamp orchid (<i>Phaius tancarvilleae</i>)	Not previously recorded in the study locality but is known to occur in northern NSW.	Endangered	Endangered
Southern swamp orchid (<i>Phaius australis</i>)	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 (*Melaleuca* 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**.

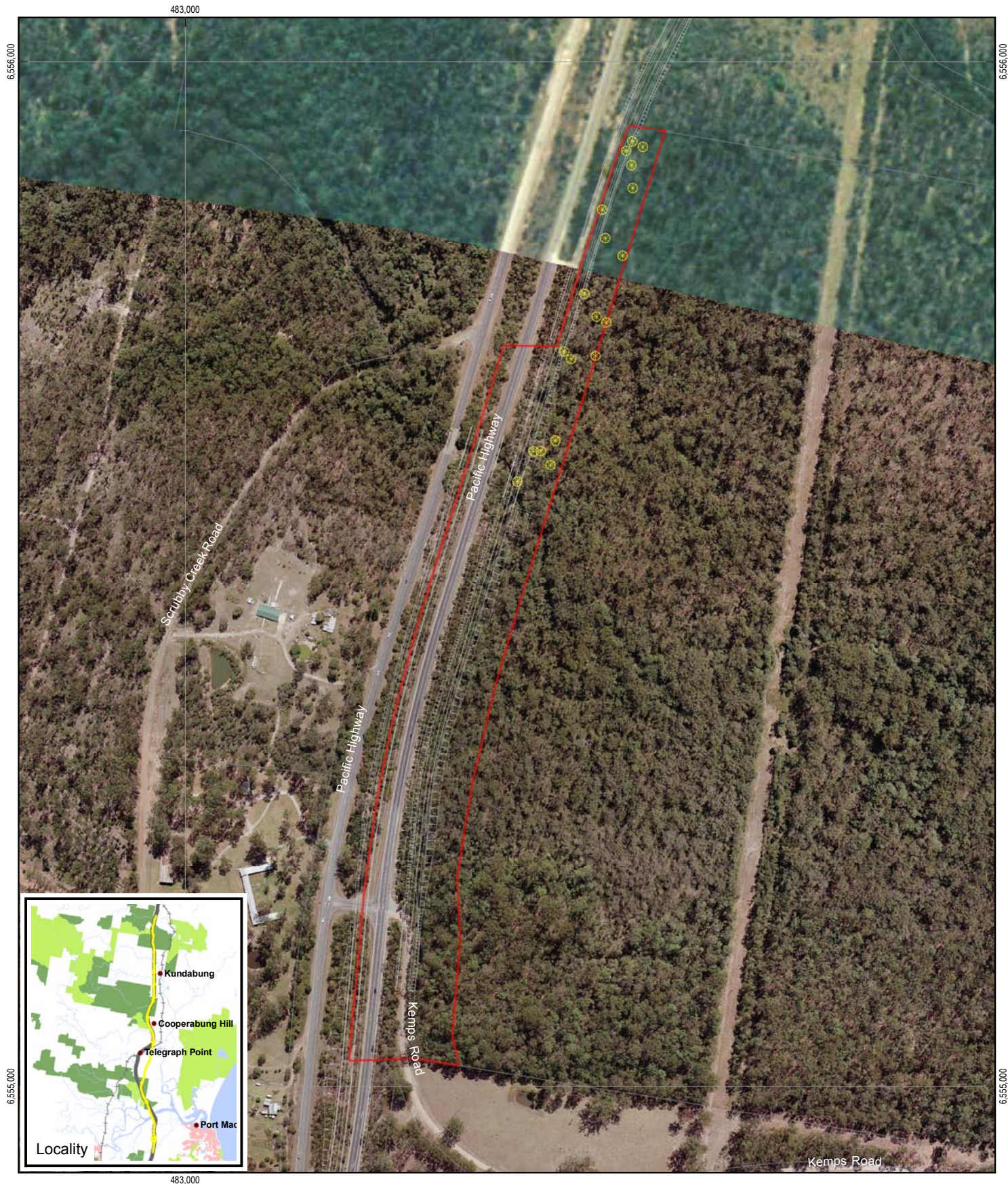
Tree-hollows of various sizes are present but not abundant within drier vegetation communities within the study area. Tree-hollows of varied sizes were abundant in the Moist Forest within Lot 80 DP 737375 with suitable for larger species, including the threatened glossy black-cockatoo, masked owl, sooty 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
<i>Eucalyptus tereticornis</i>	Forest red gum
<i>Eucalyptus pilularis</i>	Blackbutt
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus propinqua</i>	Small-fruited grey gum
<i>Eucalyptus signata</i>	Scribbly gum
<i>Eucalyptus robusta</i>	Swamp mahogany



LEGEND

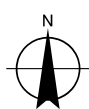
- Study Area
- ⊗ Hollow trees
- Cadastre
- Concept Design

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



Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 10 NOV 2010

Lot 80 Dp737375 (Stumpy Creek)
Tree hollow locations

Figure 3.6

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 Ballangarra – 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 (*Isodon 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 novaehollandiae*), 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	<i>Ephippiorhynchus asiaticus</i>	Endangered	
Eastern bent-wing bat	<i>Miniopterus schreibersii oceanensis</i>	Vulnerable	
Eastern false pipestrelle	<i>Falsistrellus tasmaniensis</i>	Vulnerable	

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

Common name	Scientific name	TSC Act	EPBC Act
Golden-tipped bat	<i>Kerivoula papuensis</i>	Vulnerable	
Grass owl	<i>Tyto capensis</i>	Vulnerable	
Green and golden bell frog	<i>Litoria aurea</i>	Endangered	Vulnerable
Grey-crowned babbler	<i>Pomatostomas temporalis temporalis</i>	Vulnerable	
Large-eared pied bat	<i>Chalinolobus dwyeri</i>	Vulnerable	Vulnerable
Long-nosed potoroo	<i>Potorous tridactylus</i>	Vulnerable	Vulnerable
Pale-headed snake	<i>Hoplocephalus bitorquatus</i>	Vulnerable	
Regent honeyeater	<i>Anthochaera phrygia</i>	Critically Endangered	Endangered, Migratory
Stephen's banded snake	<i>Hoplocephalus stephensii</i>	Vulnerable	
Stuttering frog	<i>Mixophyes balbus</i>	Endangered	Vulnerable
Superb fruit-dove	<i>Ptilinopus superbus</i>	Vulnerable	
Swift parrot	<i>Lathamus discolor</i>	Endangered	Endangered, Migratory
Wallum froglet	<i>Crinia tinnula</i>	Vulnerable	
Wompoo fruit-dove	<i>Ptilinopus magnificus</i>	Vulnerable	
Yellow-bellied sheath-tail bat	<i>Saccolaimus flaviventris</i>	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 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 (°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
<i>Gobiomorphus australis</i>	Striped gudgeon	1	10	27	38
<i>Hypseleotris compressa</i>	Empire gudgeon	-	6	5	11
<i>Hypseleotris galii</i>	Firetail gudgeon	-	-	1	1
<i>unknown</i>	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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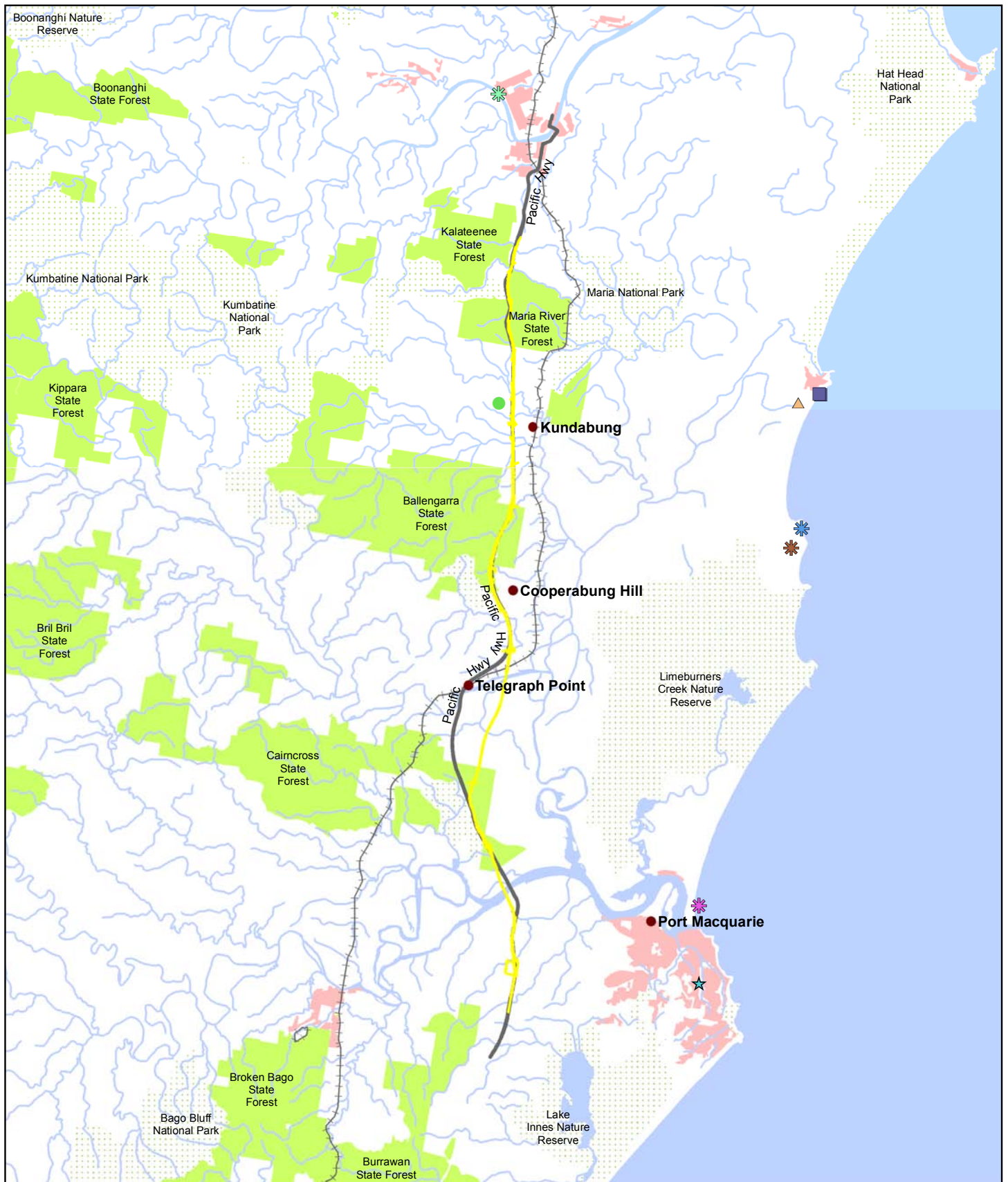
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Appendix A

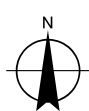
NSW DECCW Wildlife Atlas database search results



Legend

— Concept Design	 Built-up urban areas	● Hairy Jointg	★ <i>Maundia triglochi</i>	★ <i>Cynanchum elegans</i>
+ + + Railway	 National parks, Nature reserves	▲ Sand Spurge	★ <i>Asperula asthenes</i>	★ <i>Thesium australe</i>
— Existing highway	 State forests	★ Silverbush		
— Watercourse	 Austral Toad	◆ Willi Willi		

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



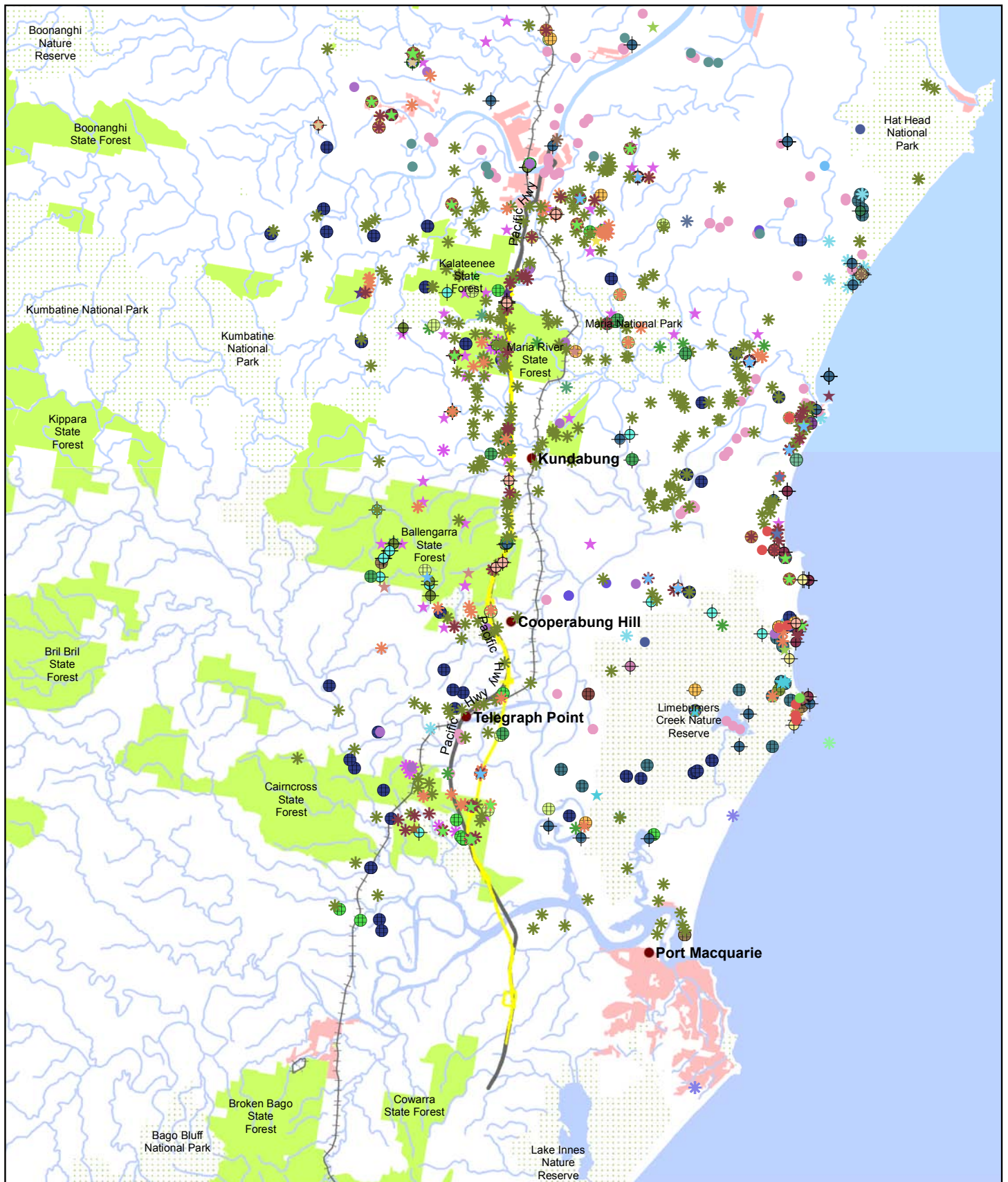
Roads and Traffic Authority
 Additional Field Survey

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
 G:\22\1205704\CADD\ArcGIS\Maps\OHK - Additional Field Survey (Nov 10)\OHK_AFS_005_Threatened_Flora_20101104_A.mxd
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 Data Source: Geosciences Australia: Topography - 2007; GHD: Concept Design - 2010; DECCW: Threatened Species Data - 2010. Created by: tmorton

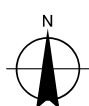


Refer to Figure 6a for key to threatened fauna species.

Threatened Fauna Records

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

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



Roads and Traffic Authority
Additional Field Survey

Job Number 22-1374532
Revision A
Date 05 NOV 2010

Threatened Fauna Records Legend

Figure 6a

Appendix B

EPBC Act Protected Matters report



Australian Government

Department of Sustainability, Environment,
Water, Population and Communities

Protected Matters Search Tool

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>

Report created: 18/01/11 13:38:09

[Summary](#)

[Details](#)

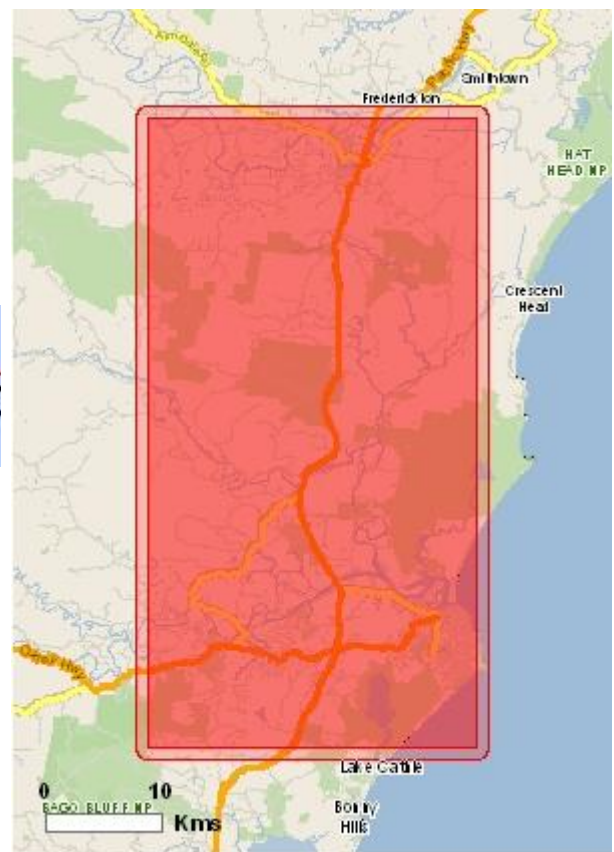
[Matters of NES](#)

[Other matters protected by
the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



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 Communities:	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] 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] Rhipidura rufifrons	Breeding likely to occur within area
Rufous Fantail [592] Xanthomyza phrygia	Breeding may occur within area
Regent Honeyeater [430]	Species or species habitat likely to occur within area

Migratory Wetlands Species

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

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 were 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 (°C).
- pH.
- Turbidity (NTU).
- Dissolved oxygen (DO) (mg/L and per cent saturation).
- Electrical conductivity (EC) ($\mu\text{S}/\text{cm}^2$).

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	<i>Brunoniella australis</i>	Blue Trumpet/ Native Yam		2				2						
ACANTHACEAE	<i>Brunoniella sp</i>	Blue Trumpet			1									
APIACEAE	<i>Hydrocotyle peduncularis</i>	Hairy Pennywort				2	2	2	2				X	
APIACEAE	<i>Hydrocotyle tripartita</i>	Pennywort				2	2		2					
APOCYNACEAE	<i>Parsonsia straminea</i>	Common Silkpod					1		2	X				
APOCYNACEAE	<i>Tabernaemontana pandacaqui</i>	Banana Bush / Windmill Bush					4							
ARALIACEAE	<i>Polyscias sambucifolia</i>	Ornamental Ash	Yes									X		
ASPARAGACEAE	<i>Asparagus aethiopicus</i>	Asparagus Fern	Yes									X		
ASTERACEAE	<i>Ageratina adenophora</i>	Crofton Weed	Yes							X				
ASTERACEAE	<i>Ageratum houstonianum</i>	-				2								
ASTERACEAE	<i>Ambrosia artemisiifolia</i>	Annual Ragweed	Yes									X		
ASTERACEAE	<i>Bidens pilosa</i>	Cobblers Pegs	Yes					1						
ASTERACEAE	<i>Cirsium vulgare</i>	Spear Thistle / Black Thistle	Yes		1									
ASTERACEAE	<i>Conyza sp.</i>	Fleabane	Yes								X			
ASTERACEAE	<i>Hypochoeris radicata</i>	Flatweed	Yes								X			
ASTERACEAE	<i>Ozothamnus diosmifolius</i>	Ball Everlasting		1									X	
ASTERACEAE	<i>Taraxacum officinal</i>	Dandelion	Yes		1		1	2					X	
BLECHNACEAE	<i>Blechnum sp</i>	Fishbone Fern								X				
BRASSICACEAE	<i>Capsella bursa-pastoris</i>	Shepherd's Purse	Yes										X	
CASUARINACEAE	<i>Allocasuarina littoral</i>	Black She-oak		4			1	2					X	
CASUARINACEAE	<i>Allocasuarina torulosa</i>	Forest Oak												X
CASUARINACEAE	<i>Casuarina glauca</i>	Swamp She-oak						4			X			
COMMELINACEAE	<i>Commelina cyanea</i>	Scurvy Weed								X				
CONVOLVULACEAE	<i>Convolvulus erubescence</i>	Blushing Bindweed			2	2		2	2					
CYPERACEAE	<i>Carex breviculmis?</i>	-				2	2	2						
CYPERACEAE	<i>Carex longibrachiata</i>	Drooping Sedge							2					
CYPERACEAE	<i>Cyperus eragrostis</i>	Umbrella Sedge	Yes				2							
CYPERACEAE	<i>Eleocharis sphacelata</i>	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	<i>Gahnia aspera</i>	Rough Saw-sedge												X
CYPERACEAE	<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge					2	2	1					
CYPERACEAE	<i>Lepidosperma lateral</i>	Flat Sword-sedge		2	2									
DENNSTAEDTIACEAE	<i>Pteridium esculentum</i>	Bracken Fern			3		2	2					X	
DICKSONIACEAE	<i>Calochlaena dubia</i>	False Bracken Fern				3	2		2					
DILLENACEAE	<i>Hibbertia aspera</i>	Rough Guinea-flower					1							
DILLENACEAE	<i>Hibbertia empetrifolia</i> subsp. <i>empetrifolia</i>	Trailing Guinea-flower				2								
DILLENACEAE	<i>Hibbertia scandens</i>	Golden Guinea Flower				2								
DILLENACEAE	<i>Hibbertia sp</i>	Guinea Flower			2									
DIOSCOREACEAE	<i>Dioscorea transversa</i>	Native Yam				2								
ERICACEAE	<i>Leucopogon sp</i>	Beard-heath		1										X
EUPHORBIACEAE	<i>Breynia oblongifolia</i>	Coffee Bush			2				1					X
EUPHORBIACEAE	<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	Cheese Tree						2						
FABACEAE	<i>Acacia falcata</i>	-											X	
FABACEAE	<i>Acacia floribunda</i>	White Sallow Wattle/Sally							1					
FABACEAE	<i>Acacia irrorata</i> subsp <i>irrorata</i>	Green Wattle				1		1					X	
FABACEAE	<i>Acacia linifolia</i>	Narrow-leaf Wattle		1	2	1	2					X	X	
FABACEAE	<i>Acacia longifolia</i>	-											X	
FABACEAE	<i>Acacia maidenii</i>	Maiden's Wattle		2	2									
FABACEAE	<i>Acacia melanoxydon</i>	Blackwood									X			
FABACEAE	<i>Acacia venulosa</i>	Wattle			2									
FABACEAE	<i>Daviesia ulicifolia</i>	A Bitter Pea			1									
FABACEAE	<i>Desmodium varians</i>	Slender Tick-trefoil			2	2							X	
FABACEAE	<i>Glycine clandestina</i>	A Love Creeper / Twining Glycine		2										
FABACEAE	<i>Glycine microphylla</i>	Small-leafed Glycine					2							
FABACEAE	<i>Glycine tabacina</i>	A Love Creeper				2								
FABACEAE	<i>Hardenbergia violaceae</i>	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	<i>Hovea linearis</i>	Rusty Pods			1									
FABACEAE	<i>Jacksonia scoparia</i>	Winged Broom-pea											X	
FABACEAE	<i>Kennedia rubicunda</i>	Dusky Coral-pea			1									
FABACEAE	<i>Pulteneae retusa</i>	A Bush-pea		1	1			1						
FABACEAE	<i>Pulteneae villosa</i>	Hairy Bush-pea											X	
FABACEAE	<i>Trifolium subterraneum</i>	Subterraneum Clover	Yes											X
GOODENIACEAE	<i>Goodenia bellidifolia</i>	Daisy-leaved Goodenia						2						
GOODENIACEAE	<i>Goodenia hederacea</i>	Ivy Goodenia		2				2						
GOODENIACEAE	<i>Goodenia rotundifolia</i>	-												X
HALORAGACEAE	<i>Gonocarpus teucrioides</i>	Germander Raspswort		2		2								
HALORAGACEAE	<i>Gonocarpus tetragynus</i>	Poverty Raspswort		2		2	2	2						
JUNCACEAE	<i>Juncus sp</i>	Rush					2							
JUNCACEAE	<i>Juncus usitatus</i>	Common Rush					2							
LAURACEAE	<i>Cinnamomum camphora</i>	Camphor Laurel	Yes								X		X	
LAURACEAE	<i>Endiandra sieberi</i>	Hard Corkwood										X		
LOBELIACEAE	<i>Lobelia anceps</i>	-					1		2					
LOBELIACEAE	<i>Pratia purpurascens</i>	White-root		2	2	2		2					X	
LOMANDRACEAE	<i>Lomandra filiformis</i> var. <i>filiformis</i>	Iron Grass		2	2			2					X	
LOMANDRACEAE	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		1	3	2	2	2					X	
LOMANDRACEAE	<i>Lomandra multiflora</i> <i>subsp multiflora</i>	Mat-rush		2										
LUZURIAGACEAE	<i>Eustrephus latifolia</i>	Wombat Berry			1	1								
MALVACEAE	<i>Sida rhombifolia</i>	Paddy's Lucerne	Yes										X	
MELIACEAE	<i>Synoum glandulosum</i>	Scentless Rosewood				1								
MENISPERMACEAE	<i>Stephanie japonica</i>	Snake Vine							2					
MORACEAE	<i>Ficus coronata</i>	Creek Sandpaper Fig				1								
MYRSINACEAE	<i>Myrsine variabilis</i>	Muttonwood				1								
MYRTACEAE	<i>Acmena smithii</i>	Lilly-pilly				1								
MYRTACEAE	<i>Acmena smithii</i>	Lilly-Pilly									X			
MYRTACEAE	<i>Babingtonia similis</i>	-		2	2		4	4						
MYRTACEAE	<i>Baeckea linifolia</i>	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	<i>Baeckea linifolia</i>	Weeping / Swamp Baeckea			2									
MYRTACEAE	<i>Callistemon salignus</i>	Willow Bottlebrush		2	2	3	2	2					X	
MYRTACEAE	<i>Corymbia intermedia</i>	Pink Bloodwood		2	2		2	1			X	X	X	
MYRTACEAE	<i>Eucalyptus carnea</i>	Broad-leaf White Mahogany		3									X	
MYRTACEAE	<i>Eucalyptus crebra</i>	Narrow-leaf Ironbark										X	X	
MYRTACEAE	<i>Eucalyptus globoidea</i>	White Stringybark			4			2				X		X
MYRTACEAE	<i>Eucalyptus microcorys</i>	Tallow-wood		1	2	2	3				X	X		
MYRTACEAE	<i>Eucalyptus pilularis</i>	Blackbutt			1								X	
MYRTACEAE	<i>Eucalyptus propinqua</i>	Small-fruited Grey-gum		2				2				X	X	
MYRTACEAE	<i>Eucalyptus resinifera</i>	Red Mahogany		1		2						X		
MYRTACEAE	<i>Eucalyptus robusta</i>	Swamp Mahogany						1						
MYRTACEAE	<i>Eucalyptus saligna</i>	Sydney Blue gum										X		X
MYRTACEAE	<i>Eucalyptus seeana</i>	Narrow-leaf Red-gum		2										
MYRTACEAE	<i>Eucalyptus siderophloia</i>	Northern Grey-gum					1							
MYRTACEAE	<i>Eucalyptus tereticornis</i>	Forest Red-gum					2	3			X			X
MYRTACEAE	<i>Leptospermum polygalifolium</i>	Tantoon			1		2							
MYRTACEAE	<i>Melaleuca linearifolia</i>	Snow-in-summer		1						X	X			
MYRTACEAE	<i>Melaleuca nodosa</i>	Ball Honey-myrtle		1										X
MYRTACEAE	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark						5						
MYRTACEAE	<i>Melaleuca styphelioides</i>	Prickly-leaved Paperbark				2	2	2						
MYRTACEAE	<i>Syncarpia glomulifera</i>	Turpentine			2	4	2							
OLEACEAE	<i>Notelaea longifolia</i>	Large Mock-olive											X	
ORCHIDACEAE	<i>Cryptostylis subulata</i>	Large Tongue-orchid				1								
OXALIDACEAE	<i>Oxalis perennans</i>	-		2			2	2						
PASSIFLORACEAE	<i>Passiflora edulis</i>	Common Passionfruit	Yes	1		1								
PHORMIACEAE	<i>Dianella caerulea</i>	Blue Flax-lily		2	2		2	2		X			X	
PHORMIACEAE	<i>Dianella sp</i>	Flax-lily				2								
PITTOSPORACEAE	<i>Billardiera scandens</i>	Apple Dumplings		2	2									
PITTOSPORACEAE	<i>Pittosporum sp</i>	-				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	<i>Plantago lanceolata</i>	Plantain	Yes										X	
POACEAE	<i>Andropogon virginicus</i>	Whisky Grass	Yes		2		2	2					X	
POACEAE	<i>Aristida ramosa</i>	Three-awned Grass			2									
POACEAE	<i>Avena fatua</i>	Wild Oats	Yes										X	
POACEAE	<i>Briza maxima</i>	Quaking Grass	Yes										X	
POACEAE	<i>Bromus cartharticus</i>	Prairie Grass	Yes								X			
POACEAE	<i>Chloris gayana</i>	Rhodes Grass	Yes										X	
POACEAE	<i>Chloris truncata</i>	Windmill Grass	Yes								X	X	X	
POACEAE	<i>Cynodon dactylon</i>	Couch	Yes							X				
POACEAE	<i>Dichelachne crinita</i>	Longhair Plumegrass												X
POACEAE	<i>Dichelachne micrantha</i>	Shorthair Plumegrass			1									
POACEAE	<i>Digitaria sp</i>	-		2	2	2								
POACEAE	<i>Entolasia marginata</i>	Bordered Panic								3				
POACEAE	<i>Entolasia stricta</i>	Wiry Panic		2	2	2	5	5					X	
POACEAE	<i>Imperata cylindrica</i>	Blady Grass			1						X	X	X	
POACEAE	<i>Microlaena stipoides</i>	Weeping Grass			2				2					X
POACEAE	<i>Oplismenus aemulus</i>	Basket Grass / Broad- leaf Beard-grass		2	2	4	2	2	5				X	
POACEAE	<i>Oplismenus imbecillis</i>	Basket Grass / Broad- leaf Beard-grass				2		2						
POACEAE	<i>Panicum queenslandicum</i> var. <i>queenslandicum</i>	Guinea Grass						2						
POACEAE	<i>Paspalidium distans</i>	-		1										
POACEAE	<i>Paspalum urvillei</i>	Tall Paspalum / Vasey Grass	Yes				2		5					
POACEAE	<i>Sporobolus fertilis</i>	Giant Parramatta Grass	Yes										X	
POACEAE	<i>Themeda australis</i>	Kangaroo Grass		2	3		2	2				X	X	
POLYGALACEAE	<i>Comesperma ericinum</i>	Match Heads						1						
PROTEACEAE	<i>Banksia spinosa</i>	Hill Banksia		1										
PROTEACEAE	<i>Banksia spinulosa</i> var. <i>collina</i>	Hill Banksia			1									
PROTEACEAE	<i>Lomatia silaifolia</i>	Crinkle Bush			1									
PROTEACEAE	<i>Persoonia katerae</i>	-			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	<i>Alphitonia excelsa</i>	Red Ash								X				
RUBIACEAE	<i>Opercularia aspera</i>	Stink weed		2	2									
RUBIACEAE	<i>Pomax umbellata</i>	Pomax		2										
RUTACEAE	<i>Acronychia oblongifolia</i>	Common Acronychia								X				
SANTALACEAE	<i>Exocarpos cupressiformis</i>	Cherry Ballard										X		X
SAPINDACEAE	<i>Dodonea triquetra</i>	Common Hopbush				1								
SCROPHULARIACEAE	<i>Veronica notabilis</i>	Forest Speedwell			2									
SINOPTERIDACEAE	<i>Cheilanthes sieberi</i>	Mulga Fern		1										
SINOPTERIDACEAE	<i>Cheilanthes sieberi subsp sieberi</i>	Mulga Fern		2										
SOLANACEAE	<i>Solanum mauritianum</i>	Wild Tobacco-bush										X		
SOLANACEAE	<i>Solanum sp</i>	-								X				
SOLANACEAE	<i>Solanum nigrum</i>	Blackberry Nightshade	Yes								X			
VERBENACEAE	<i>Lantana camara</i>	Lantana	Yes		2	2	2		2		X	X		X
VERBENACEAE	<i>Verbena bonariensis</i>	Purpletop	Yes										X	
VIOLACEAE	<i>Viola betonicifolia</i>	Purple Violet			1					X				
VIOLACEAE	<i>Viola hederacea</i>	Ivy-leaved Violet				2	2	2	2					
VITACEAE	<i>Cissus antarctica</i>	Kangaroo Grape		1	1									
XANTHORRHOEACEAE	<i>Xanthorrhoea latifolia</i>	-											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	<i>Antechinus stuartii</i>	Brown Antechinus		
DASYURIDAE	<i>Antechinus swainsonii</i>	Dusky Antechinus		
MACROPODIDAE	<i>Macropus giganteus</i>	Eastern Grey Kangaroo		
MACROPODIDAE	<i>Macropus rufogriseus</i>	Red-necked Wallaby		
MOLOSSIDAE	<i>Mormopterus norfolkensis</i>	East-coast Freetail Bat	Vulnerable	
MOLOSSIDAE	<i>Mormopterus sp unk</i>	-		
MOLOSSIDAE	<i>Mormopterus sp. 2</i>	-		
MURIDAE	<i>Rattus fuscipes</i>	Bush Rat		
PHALANGERIDAE	<i>Trichosurus vulpecula</i>	Common Brushtail Possum		
PSEUDOCHEIRIDAE	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum		
PSEUDOCHEIRIDAE	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Vulnerable	Vulnerable
RHINOLOPHIDAE	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe Bat		
VESPERTILIONIDAE	<i>Chalinolobus morio</i>	Chocolate Wattled Bat		
VESPERTILIONIDAE	<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat	Vulnerable	
VESPERTILIONIDAE	<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Vulnerable	
VESPERTILIONIDAE	<i>Miniopterus australis</i>	Little Bent-wing Bat	Vulnerable	
VESPERTILIONIDAE	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	Vulnerable	
VESPERTILIONIDAE	<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat		
VESPERTILIONIDAE	<i>Nyctophilus sp</i>	Longear Bat		
VESPERTILIONIDAE	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	Vulnerable	
VESPERTILIONIDAE	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat		
VESPERTILIONIDAE	<i>Nyctinomus australis</i>	White-striped Freetail Bat		
VESPERTILIONIDAE	<i>Vespadelus pumilis</i>	Eastern Forest Bat		
VESPERTILIONIDAE	<i>Vespadelus vulturnus</i>	Little Forest Bat		

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

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

Family	Scientific Name	Common Name	TSC Act	EPBC Act
MYOBATRACHIDAE	<i>Crinia signifera</i>	Common Eastern Froglet		
MYOBATRACHIDAE	<i>Limnodynastes peronii</i>	Brown Striped Marsh Frog		
MYOBATRACHIDAE	<i>Pseudophryne coriacea</i>	Red-braked Toadlet		
MYOBATRACHIDAE	<i>Uperoleia laevisgata</i>	Smooth Toadlet		
REPTILES				
VARANIDAE	<i>Varanus varius</i>	Lace Monitor		
AGAMIDAE	<i>Physignathus lesueurii</i>	Eastern Water Dragon		
SCINCIDAE	<i>Lampropholis delicata</i>	Sunskink		
FISH				
ELEOTRIDIDAE	<i>Gobiomorphus australis</i>	Striped gudgeon		
ELEOTRIDIDAE	<i>Hypseleotris compressa</i>	Empire gudgeon		
ELEOTRIDIDAE	<i>Hypseleotris galii</i>	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 (<i>Botaurus poiciloptilus</i>)	Endangered	-	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (<i>Typha spp.</i>) and spikerushes (<i>Eleocharis spp.</i>). 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 (<i>Rostratula australis</i>)	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 (<i>Ninox connivens</i>)	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 (<i>Coracina lineata</i>)	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 (<i>Esacus neglectus</i>)	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 (<i>Ixobrychus flavicollis</i>)	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 (<i>Hamirostra melanosternon</i>)	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	-

APPENDIX F | ASSESSMENT OF LIKELIHOOD OF THREATENED SPECIES OCCURRING IN 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				
Black-necked stork (<i>Ephippiorhynchus asiaticus</i>)	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 (<i>Oxyura australis</i>)	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 (<i>Grus rubicundus</i>)			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 (<i>Climacteris picumnus</i>)	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 (<i>Burhinus grallarius</i>)	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 (<i>Irediparra gallinacea</i>)	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	√

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				Breeding	Roosting	Foraging				
Little eagle (<i>Hieracetus morphoides</i>)	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 (<i>Glossopsitta pusilla</i>)	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 (<i>Stictonetta naevosa</i>)	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 (<i>Petroica phoenicea</i>)	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 sedgeland at high altitudes. Prefers clearings or areas with open understoreys.	N		N	Unlikely	N/A	N/A	
Flesh-footed shearwater (<i>Puffinus carneipes</i>)	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 (<i>Calyptorhynchus lathamii</i>)	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 (<i>Allocasuarina littoralis</i>), forest she-oak (<i>A. torulosa</i>) or drooping she-oak (<i>A. verticillata</i>) occur. In the Riverina area, inhabits open woodlands dominated by belah (<i>Casuarina cristata</i>). Feeds almost exclusively on the seeds of several species of she-oak (<i>Casuarina</i> and <i>Allocasuarina</i> 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 (<i>Tyto capensis</i>)	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 (<i>Pomatostomus temporalis</i>)	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 (<i>Melanodryas cucullata</i>)	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 (<i>Podargus ocellatus</i>)	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 (<i>Sula dactylatra</i>)	Vulnerable		Marine species.	N	N	N	Unlikely	N/A	N/A	

APPENDIX F | ASSESSMENT OF LIKELIHOOD OF THREATENED SPECIES OCCURRING IN 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				
Masked owl (<i>Tyto novaehollandiae</i>)	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 (<i>Pachycephala olivacea</i>)			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 (<i>Pandion haliaetus</i>)	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 (<i>Grantiella picta</i>)	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 <i>Amyema</i> . 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 (<i>Haematopus longirostris</i>)	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 (<i>Ninox strenua</i>)	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 <i>Syncarpia glomulifera</i> , black she-oak <i>Allocasuarina littoralis</i> , blackwood <i>Acacia melanoxylon</i> , rough-barked apple <i>Angorophora floribunda</i> , cherry ballart <i>Exocarpus cupressiformis</i> 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 (<i>Xanthomyza phrygia</i>)	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	√

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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 (<i>Ptilinopus regina</i>)	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 (<i>Atrichornis rufescens</i>)	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 (<i>Petroica boodang</i>)	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 (<i>Tyto tenebricosa</i>)	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 (<i>Pyrrholaemus sagittatus</i>)	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 (<i>Lophoictinia isura</i>)	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 (<i>Ptilinopus superbus</i>)	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 (<i>Lathamus discolor</i>)	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 <i>E. siderophloia</i> , 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 (<i>Neophema pulchella</i>)	Vulnerable		Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland	N	-	N	Unlikely	N/A	N/A	

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				Breeding	Roosting	Foraging				
Varied sittella (<i>Daphoenositta chrysoptera</i>)	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 (<i>Ptilinopus magnificus</i>)	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 (<i>Charadrius leschenaultii</i>)	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 (<i>Charadrius mongolus</i>)	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 (<i>Sterna albifrons</i>)	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 (<i>Haematopus fuliginosus</i>)	Vulnerable		Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries.	N	N	N	Unlikely	N/A	N/A	

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				Breeding	Roosting	Foraging				
Terek sandpiper (<i>Xenus cinereus</i>)	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 (<i>Mixophyes iteratus</i>)	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 (<i>Litoria aurea</i>)	Endangered	Vulnerable	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (<i>Typha</i> spp.) or spikerushes (<i>Eleocharis</i> spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as plague minnow (<i>Gambusia holbrooki</i>), 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	√

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				Breeding	Roosting	Foraging				
Green-thighed frog (<i>Litoria brevipalmata</i>)	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 (<i>Philoria sphagnicolus</i>)	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 (<i>Mixophyes balbus</i>)	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 (<i>Crinia tinnula</i>)	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 (<i>Hoplocephalus bitorquatus</i>)	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	√

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				Breeding	Roosting	Foraging				
Stephens' banded snake (<i>Hoplocephalus stephensii</i>)	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 (<i>Phascogale tapoatafa</i>)	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 (<i>Petrogale penicillata</i>)	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 (<i>Planigale maculata</i>)	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 (<i>Psuedomys gracilicaudatus</i>)	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	√

APPENDIX F | ASSESSMENT OF LIKELIHOOD OF THREATENED SPECIES OCCURRING IN 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				
Eastern pigmy possum (<i>Cercartetus nanus</i>)	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 (<i>Dasyurus viverrinus</i>)	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 (<i>Dromaius novaehollandiae</i>) - 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 (<i>Phascolarctos cinereus</i>)	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 (<i>Potorous tridactylus</i>)	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 (<i>Pseudomys novaehollandiae</i>)		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 (<i>Macropus parma</i>)	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 (<i>Aepyprymnus rufescens</i>)	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 (<i>Dasyurus maculatus</i>)	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 (<i>Petaurus norfolcensis</i>)	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	√

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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 (<i>Petaurus australis</i>)	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 (<i>Syconycteris australis</i>)	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 (<i>Miniopterus schreibersii oceanensis</i>)	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 (<i>Mormopterus</i> <i>species</i>)[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 (<i>Falsistrellus</i> <i>tasmaniensis</i>)	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 <i>Nyctophilus bifax</i>	Vulnerable		Species favours wetter habitats, ranging from rainforest and monsoon forests to riverine paperbark forests. May also inhabit 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 (<i>Kerivoula papuensis</i>)	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 (<i>Scoteanax</i> <i>rueppellii</i>)	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.		√

APPENDIX F | ASSESSMENT OF LIKELIHOOD OF THREATENED SPECIES OCCURRING IN 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				
Grey-headed flying-fox (<i>Pteropus poliocephalus</i>)	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 (<i>Chalinolobus nigrogriseus</i>)	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 (<i>Chalinolobus dwyeri</i>)	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 (<i>Miniopterus australis</i>)	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 (<i>Myotis macropus</i>)	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 (<i>Saccolaimus flaviventris</i>)	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 (<i>Petalura gigantea</i>)	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 (<i>Argyreus hyperbius</i>)	Endangered		Very localised distribution – restricted to open swampy coastal areas where the larval food plant (<i>Viola betonicifolia</i>) 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
<i>Acronychia littoralis</i> (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 <i>Acronychia oblongifolia</i>	N/A	N/A	Y
<i>Allocasuarina defungens</i> (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
<i>Arthraxon hispidus</i> (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
<i>Chamaesyce psammogeton</i> (sand spurge)	Endangered		Grows on fore-dunes and exposed headlands, often with spinifex (<i>Spinifex sericeus</i>).	No	Low – no suitable habitat present	N/A	N/A	N
<i>Cynanchum elegans</i> (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 <i>Melaleuca armillaris</i> scrub to open scrub.	Possibly in rainforest areas or moist gullies	Low – no suitable habitat present	N/A	N/A	N
<i>Cryptostylis hunteriana</i> (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
<i>Hakea archaeoides</i> (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
<i>Hydrocharis dubia</i> (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
<i>Marsdenia longiloba</i> (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
<i>Maundia triglochoides</i>	Vulnerable		Swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Associated with wetland species e.g. <i>Triglochin procerum</i> .	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
<i>Melaleuca biconvexa</i> (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
<i>Melaleuca groveana</i> (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
<i>Oberonia titania</i> (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

APPENDIX F | ASSESSMENT OF LIKELIHOOD OF THREATENED SPECIES OCCURRING IN 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
<i>Parsonsia dorrigoensis</i> (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
<i>Phaius australis</i> (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
<i>Phaius tankervilleae</i> (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
<i>Quassia</i> 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	-
<i>Taeniophyllum muelleri</i> (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	-
<i>Thesium australe</i> (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 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 Floodplain Forest	Oak 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 meadows, freshwater sedgeland, 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 sheath-tail-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 sheath-tail-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 sheath-tail-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 sheath-tail-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 sheath-tail-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 (*Phascogale 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 desirable. 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 (*Calyptorhynchus 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 folivore, 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 potential 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 stephensi*) – 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 sedgeland 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 poiciliptilus*), 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 been 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	<i>Acronychia littoralis</i>	scented acronychia	E
	<i>Phaius tancarvilleae</i>	swamp orchid	E
	<i>Phaius australis</i>	southern swamp orchid	E
	<i>Arthraxon hispidus</i>	hairy-joint grass	V
	<i>Parsonsia dorrigoensis</i>	milky silkpod	E
Threatened fauna	<i>Mixophyes iteratus</i>	giant barred frog	E
	<i>Anthochaera phrygia</i>	regent honeyeater	E
	<i>Pseudomys novaehollandiae</i>	New Holland mouse	V
	<i>Lathamus discolor</i>	swift parrot	E
	<i>Dasyurus maculatus</i>	spotted-tailed quoll	E
	<i>Pteropus poliocephalus</i>	grey-headed flying-fox	V
	<i>Potorous tridactylus</i>	long-nosed potoroo	V
	<i>Litoria aurea</i>	green and golden bell frog	V
	<i>Chalinolobus dwyeri</i>	large-eared pied bat	V
	<i>Rostratula benghalensis</i>	Australian painted snipe	V
	<i>Mixophyes balbus</i>	stuttering frog	V

Group	Scientific Name	Common Name	EPBC Act Status
Migratory fauna	<i>Ardea ibis</i>	cattle egret	M
	<i>Monarcha melanopsis</i>	black-faced monarch	M
	<i>Gallinago hardwickii</i>	Latham's snipe	M
	<i>Pandion haliaetus</i>	osprey	M
	<i>Rhipidura rufifrons</i>	rufous fantail	M
	<i>Myiagra cyanoleuca</i>	satin flycatcher	M
	<i>Haliaeetus leucogaster</i>	white-bellied sea-eagle	M
	<i>Hirundapus caudacutus</i>	white-throated needletail	M
	<i>Rostratula australis</i>	Australian snipe	M
	<i>Apus pacificus</i>	fork-tailed swift	M
	<i>Ardea alba</i>	great egret	M
	<i>Merops ornatus</i>	rainbow bee-eater	M
	<i>Anthochaera phrygia</i>	regent honeyeater	M
	<i>Monarcha trivirgatus</i>	spectacled monarch	M
	<i>Lathamus discolor</i>	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 if 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 an 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 Kilns 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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Appendix C

Median Widening Assessment – Preliminary Scoping Investigation

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Roads and Traffic Authority

**Pacific Highway Upgrade -
Oxley Highway to Kempsey**

**Median Widening Assessment -
Preliminary Scoping Investigation**

February 2011



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Figure 5 Typical widened median sketch design – with
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Appendices

- A Selection criteria
- B Key features
- C Constraints analysis
- D Strategic cost estimate – additional costs

Executive summary

The Environmental Assessment for the upgrade of the Pacific Highway between the Oxley Highway and Kempsey identified the need for aerial fauna crossings (glider poles) at a number of locations for arboreal fauna which do not utilise underpasses. In addition to the need for glider poles, a commitment was made in the Environmental Assessment that consideration would be given to the potential for median widening at those locations where it is reasonable and feasible to do so.

This preliminary median widening assessment has considered the feasibility of widened medians at locations currently proposed for glider poles.

Based on this preliminary assessment, it is recommended that the following sites require further investigation (as detailed in this report) to determine their suitability for median widening:

- ▶ Cairncross 1 (between station 10000 to 11600).
- ▶ Ballengarra 1b (between station 23200 to 23940).
- ▶ Maria River 1b (between station 33760 to 34380).

The next stage of the assessment would be the completion of detailed investigations into the suitability of these three sites for median widening as an alternative to the glider poles identified in the Environmental Assessment. This next stage would be carried out in consultation with relevant agencies.

1. Introduction

1.1 Purpose

The Environmental Assessment for the upgrade of the Pacific Highway between the Oxley Highway and Kempsey identified the need for aerial fauna crossings (glider poles) for arboreal fauna which do not utilise underpasses at a five locations. These proposed crossings have been located to link areas of key habitat and native vegetation, particularly within sub-regional and regional corridors.

The purpose of this report is to document the findings of the preliminary investigations into the feasibility of providing median widening at locations currently proposed for glider poles within the Oxley Highway to Kempsey Pacific Highway upgrade (the Proposal).

A commitment was made in the environmental assessment that consideration would be given to the potential for median widening at these locations where it is reasonable and feasible to do so, in consultation with relevant government agencies.

Median widening is an alternative means of providing for safe crossing opportunities for gliding species, essentially by retaining mature vegetation between carriageways to allow gliding species to cross the upgraded highway in a staged manner.

1.2 Assessment background

1.2.1 The Proposal

The Proposal is part of the Pacific Highway Upgrade Program being implemented by the NSW Roads and Traffic Authority (RTA).

The Proposal is 37 kilometres in length, commencing approximately 700 metres north of the Oxley Highway interchange, tying in with the existing dual carriageways to the south, and continues northwards to tie in at Stumpy Creek with the dual carriageways of the approved Kempsey to Eungai Pacific Highway upgrade currently under construction. 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 Kempsey bypass section of the approved Kempsey to Eungai upgrade. The majority of the Proposal (20 kilometres) would be a duplication of the existing Pacific Highway. Three sections of the Proposal would deviate from the alignment of the existing highway. These are in the vicinity of the Hastings River (four kilometre deviation), a bypass of Telegraph Point (eight kilometre deviation) and through the Maria River State Forest (five kilometre deviation). The existing highway would be retained wherever possible for use as a service road or local road connection.

A detailed description of the Oxley Highway to Kempsey Pacific Highway upgrade is found in the Oxley Highway to Kempsey Environmental Assessment prepared by RTA in September 2010.

1.2.2 Ecological context

Comprehensive ecological investigations have been undertaken for the Proposal, commencing during the route options development phase, and continuing through the preferred route selection, concept design and environmental assessment phases. This has allowed the development of an alignment that sought to minimise ecological impacts while achieving the Pacific Highway Upgrade Program and Proposal objectives.

The study area contains a range of habitats including low-lying floodplains, riparian zones and drier sclerophyll forest on hilltops in more undulating terrain. Approximately one third of the study area consists of cleared land, with the bulk of the remainder occupied by native vegetation. Most of the native vegetation within the study area is contained in State forests and nature reserves, though some occurs on private land. During the field surveys, 18 threatened fauna species and four endangered ecological communities were recorded within the study area. Additional threatened flora and fauna species have potential to occur, based on the availability of suitable habitat.

The following threatened species summarised in Table 1 are of relevance to this median widening assessment.

Table 1 Threatened gliders

Name	TSC Act	EPBC Act	Recorded	Predicted
Yellow-bellied glider <i>Petaurus australis</i>	Vulnerable	--	Ballengarra State Forest	Rawdon Creek Nature Reserve
Squirrel glider <i>Petaurus norfolcensis</i>	Vulnerable	--	No	Cairncross State Forest Ballengarra State Forest Cooperabung Creek Nature Reserve Maria River State Forest Kumbatine National Park

Aerial fauna crossings

The Environmental Assessment for the Proposal identified the need to consider aerial fauna crossings at a number of locations for arboreal fauna which do not utilise underpasses, as shown on Figure 1, Figure 2 and Figure 3. These proposed crossings have been located to link areas of key habitat and native vegetation, particularly within sub-regional and regional corridors.

The location and type of the crossings has also taken into consideration the fauna species that would be likely to utilise the individual aerial crossing locations. The crossing types proposed were comprised of:

- Rope ladders: principally catering for arboreal wildlife, such as possums and gliders.
- Glider poles: designed specifically for glider species.

The actual number, location and design of the aerial crossing points to be provided would be determined during the detailed design phase in consultation with the NSW Department of Environment, Climate Change and Water (DECCW), and finalised following completion of vegetation clearing during construction.

The spacing and height of glider poles is critical to the success of this aerial crossing type for glider species, with the maximum glide distance being directly proportional to the available launch height. The following generic design guidelines would be used to design glider poles to be installed as part of the Proposal:

- Poles should be positioned to ensure a continual and consistent line of poles linking vegetation on one side of the road to the other.
- Poles should be as tall as possible (at least 10 metres in height) to maximise the glide distance available to gliders.
- In circumstances where the road surface is lower (ie in cutting) than the landscape on either side, the central poles (within the median strip) would need to be taller to ensure gliders could glide to the nearest roadside pole.
- If reflective shields are placed around the base of glider poles, a gap should be retained to allow gliders the ability to climb back from the ground.
- Glider poles should be as natural as possible (avoid using treated pine) and could be constructed using local mature trees that are cleared for the Proposal.
- The location of aerial crossings in relation to overhead powerlines needs to be carefully assessed as they could pose a serious hazard to the effectiveness of the crossing.
- Because of the known risk to fauna, and gliders in particular, of entanglement, no barbed wire should be used in any boundary fencing erected as part of the Proposal in areas where glider poles are proposed.

Assessment of aerial crossing alternatives

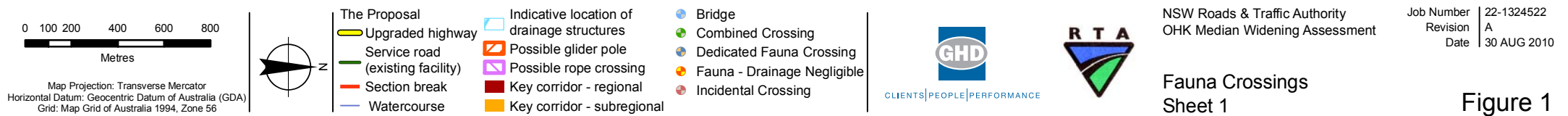
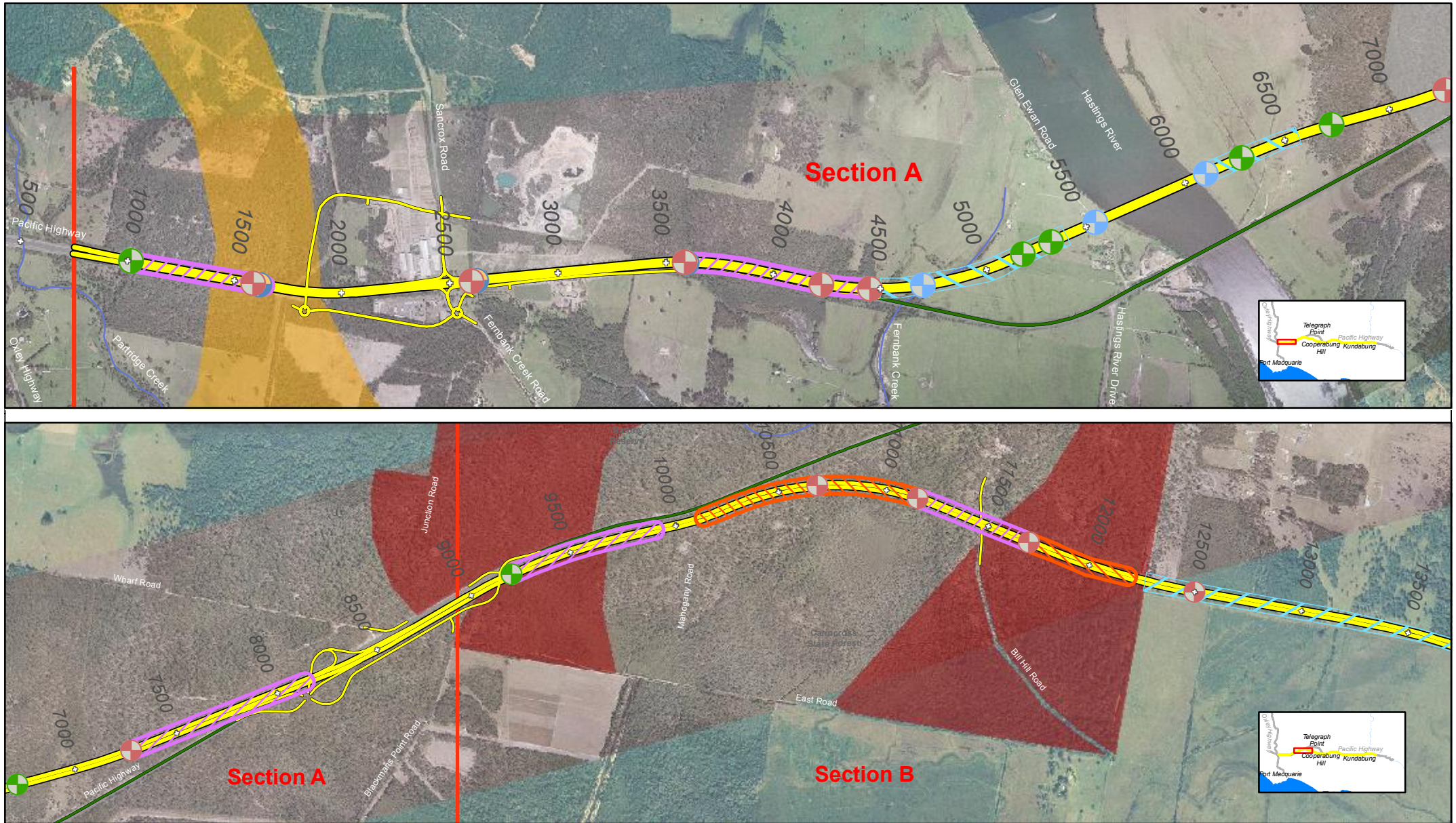
The RTA has received advice from DECCW during the planning of recent Pacific Highway upgrade projects that the provision of glider poles may not always offer safe crossing points for glider species. This is mainly due to the glide distances required to cross the two carriageways.

The success of the glider crossing points is dependant on the height of, and glide distance between, launching and landing sites such as trees or poles. The height of available launching sites, the overall width of dual carriageway roads, as well as any cross slope gradients, can makes it difficult to achieve suitable glide distances. Where suitable glide distances can not be achieved, it then becomes necessary to provide a staging point in the median area of these dual carriageway roads to provide safe passage for glider species.

An assessment of alternative options to the provision of glider poles in the median at aerial crossing locations is therefore warranted.

The assessment of potential median widening as an alternative for the proposed rope ladder crossing locations was however not considered to be necessary as the safe use of this crossing type by arboreal species is not necessarily dependant on the availability of a staging point in the median area. This median widening assessment is therefore only focused on those locations proposed for glider poles as shown on Figure 1, Figure 2 and Figure 3.

Should these potential locations be found not to be reasonable or feasible for median widening, glider poles would be installed as proposed in the environmental assessment.



Fauna Crossings
Sheet 1

Figure 1

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Data Source: RTA: Aerial Photography - 2004. Created by: gmodiarmid

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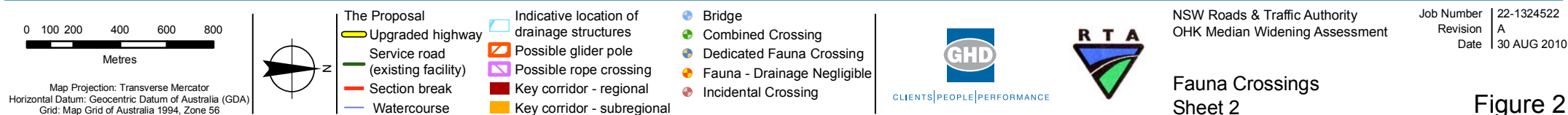
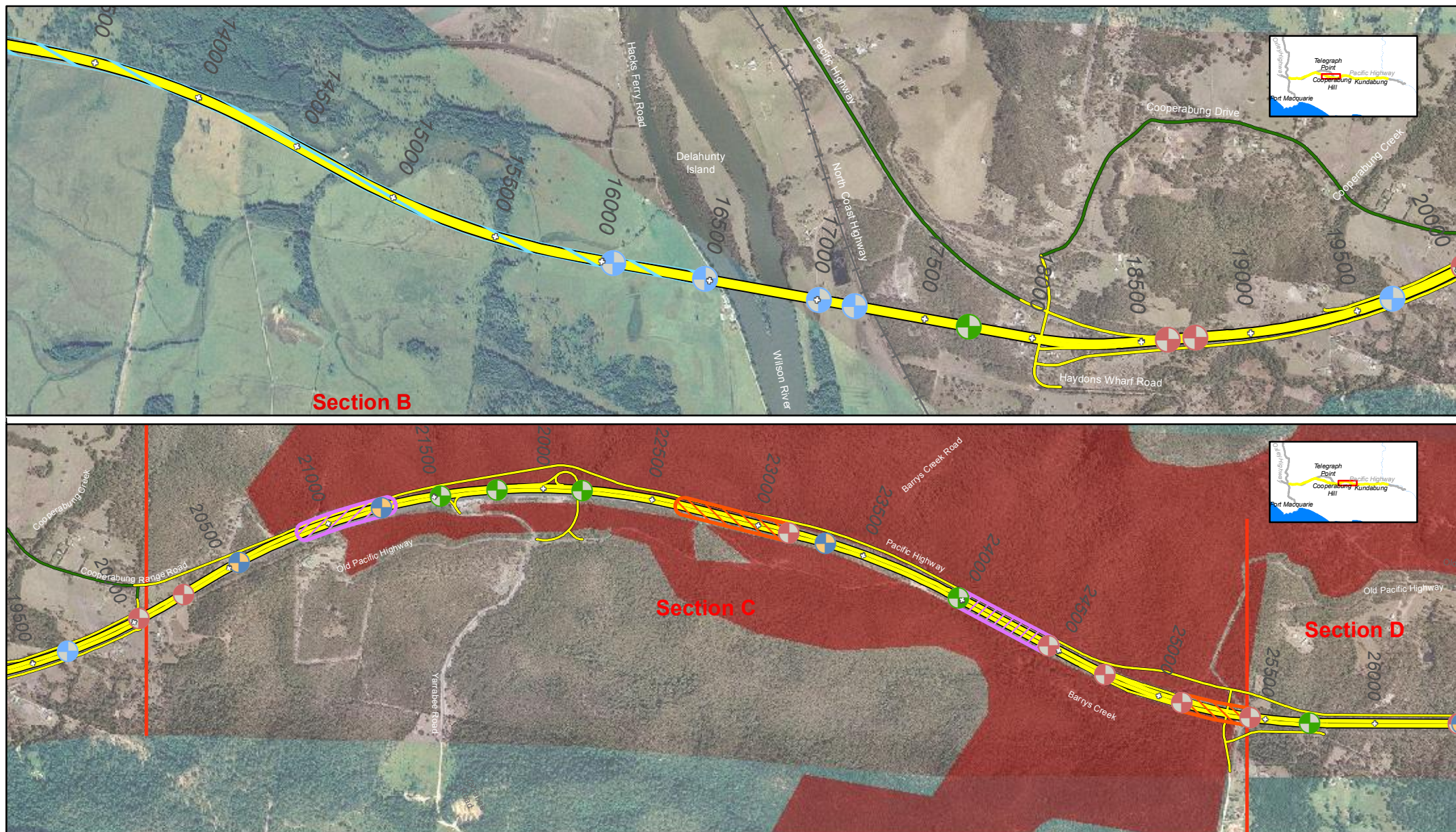
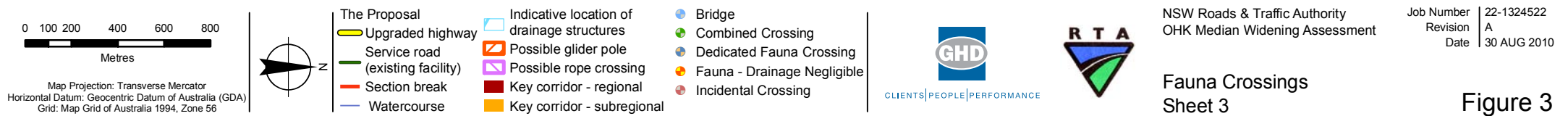
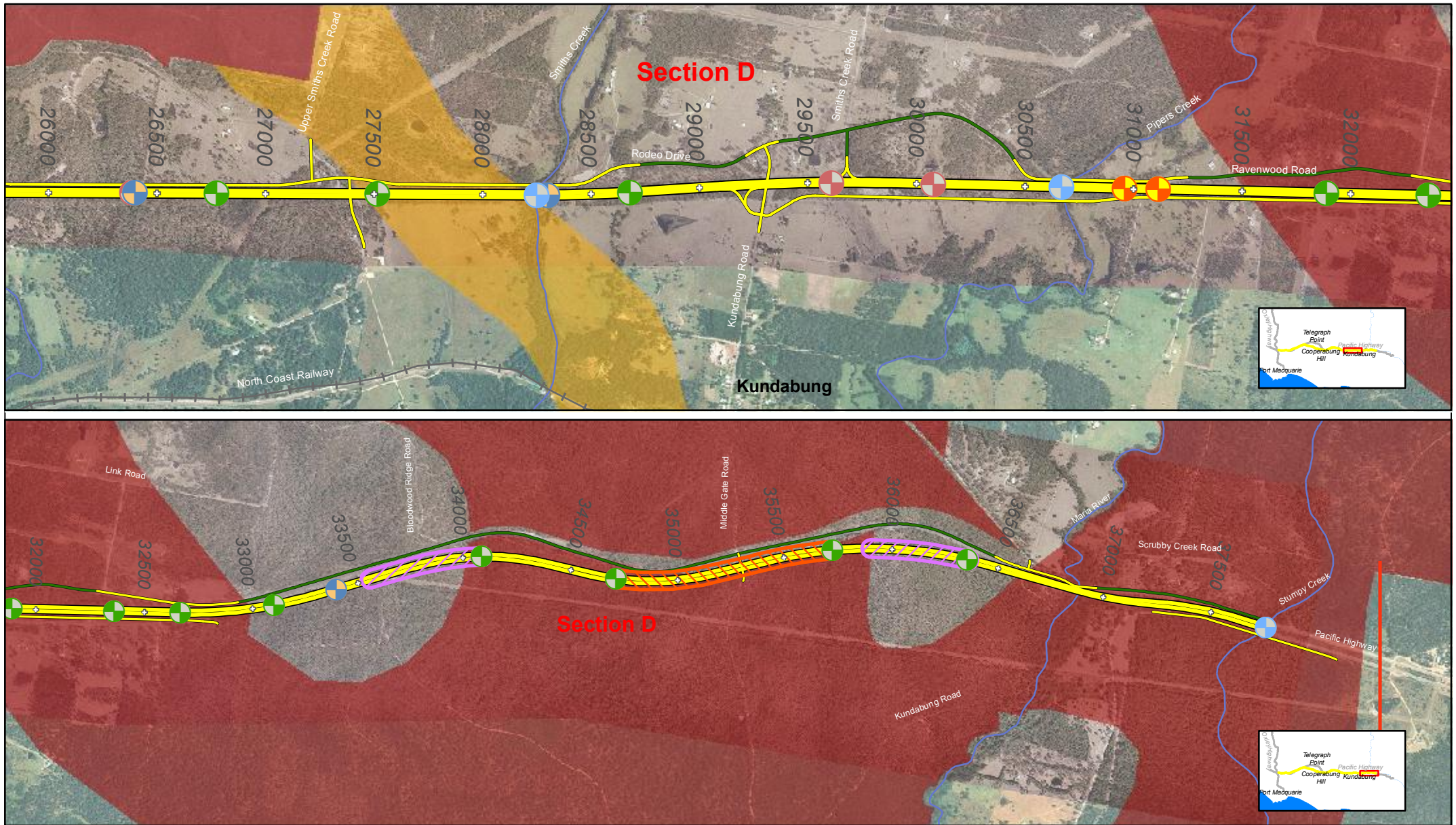


Figure 2



Fauna Crossings
Sheet 3

Figure 3

1.2.3 Median widening

Median widening is an alternative means of providing safe crossing opportunities for gliding species in locations where mature vegetation between carriageways would allow gliding species to cross the upgraded highway in a staged manner.

Typical sketches of the desired median widening design are shown in Figure 4 and Figure 5.

There are many factors that would influence the success or otherwise of median widening as a glider crossing option. These include:

- The height and density of adjacent vegetation, as well as the vegetation to be retained in the median area.
- Whether the carriageways are in cut or fill, the surrounding topography and the extent of cross slope.
- Whether or not there is an adjacent service road (in cut or fill), new or existing, or other adjacent potential barrier.
- Typical glide angles and distances (Table 2) for the target species.

Table 2 Typical glide angles and distances

Species	Average glide length	Spacing between structures
Squirrel glider <i>Petaurus norfolcensis</i>	80 m with a launch height of 45 m ^A . Maximum glide was 80 m with an average of 30-40 m ^B . Average glide length is 1 m with 1 m decrease in height.	Maximum distance of pole from other poles and trees is 60 m ^C .
Yellow-bellied glider <i>Petaurus australis</i>	Maximum 30 m glide ^D .	No more than 30 m.

Source: RTA (A: AMBS 2001, B: van der Ree 2006, C: Weston, D: Strahan 1995).

NO MINIMUM 50m LANE LINE TO LANE LINE

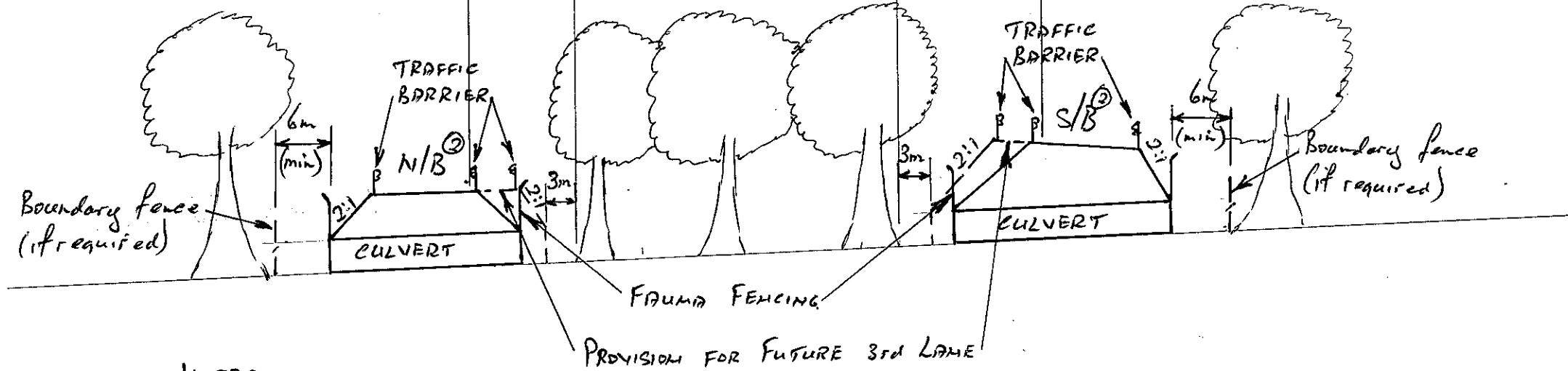
PROVIDES : 20m vegetation (min)

7m widening for 3rd lane (2x3.5m)

6m Cleared area between edge of vegetation and headwall (2x3m)

17m Batters & verges (2 off)

RETAINED VEGETATION
(minimum width 20m) ①



NOTES

- ① Other than at start and finish of median widening
- ② Independantly graded carriageways.

WIDE MEDIAN

TYPICAL CROSS SECTION AT CULVERTS
(DRAINAGE STRUCTURES AND/OR FAUNA CROSSINGS)

2. Methodology

The assessment of the potential for median widening is a staged process. Those stages are:

- Preliminary scoping investigation: Identifying potential glider crossing locations and review of existing project information to determine the feasibility of adopting median widening at these locations (as detailed in this report).
- Stage 1 – Detailed investigation: Undertaking further detailed investigation into the suitability of the locations identified in the preliminary scoping investigation as median widening locations. This stage would include consultation with the relevant agencies (during detailed design).
- Stage 2 – Finalisation and approval: Finalisation and approval of locations identified in Stage 1 for median widening by relevant agencies (during detailed design).

2.1 Preliminary scoping investigation

The preliminary scoping investigation involved the following tasks as outlined below.

2.1.1 Workshop 1

This workshop was attended by senior RTA and GHD project team members with experience in project management, engineering design, environmental planning and environmental science. The workshop considered those aerial crossing sites identified in the Environmental Assessment together with several additional adjacent locations and established a series of selection criteria that would be applied to determine the feasibility of median widening at those sites.

2.1.2 Desktop review

A desktop review was undertaken of the existing information collected for the Proposal to identify the key features, issues and opportunities for the identified selection criteria (Appendix B). This review identified the limitations of the existing data, identified any additional data required to allow the assessment to be undertaken, and determined the extent of the area to be covered by the assessment at each site.

2.1.3 Workshop 2

This workshop examined the outcomes of the desktop review and other relevant information and used the information to identify the level of constraint for each site with regard to the selection criteria adopted in workshop 1 (Section 2.1.1). A recommendation was made on the feasibility of adopting median widening at each of the identified sites.

The following list sets out the level of constraint assigned for each of the assessment criteria in the workshop:

- Negligible (a score of 0).
- Low (a score of 1).

- Medium (a score of 2).
- High (a score of 3).
- Significant (a score of 4).

The level of constraint was determined relative to the current concept design at each site as follows:

- A negligible constraint indicates no difference between the existing concept design and proposed widened median at that location (eg similar amount of vegetation clearing).
- Constraints from low to high were allocated depending on the assessed difference between the existing concept design and proposed widened median at that location.
- A significant constraint indicates that the impact of the widened median is significantly worse when compared with the existing concept design (eg significantly greater amount of clearing of endangered ecological communities) at that location or the revised design would require significant modification from the existing concept design (eg realignment of Barrys Creek).

2.2 Future stages

2.2.1 Stage 1 – Detailed investigation

Those sites that are recommended by this preliminary scoping investigation (refer to Section 4 of this report) would be subject to further detailed investigation. This would include:

- Preliminary engineering design.
- Identification of additional property acquisition and footprint clearing requirements.
- Field investigations as necessary.
- Consultation with affected landowners.
- Preparation of preliminary cost estimates.
- Analysis to quantify the benefits and impacts based on the preliminary designs.
- Input from the relevant agencies.

Following completion of the above tasks, the selected sites would be reviewed at a workshop involving the RTA and agencies such as DECCW and Industry and Investment NSW (I&I NSW) to assess the level of relative constraint and impact, as well as the benefits to be gained by median widening at the recommended locations. While this investigation would be undertaken at a greater level of detail than that completed during the preliminary scoping investigation, the selection criteria used previously would be used as the basis for further investigations and discussions with the agencies.

The outcome of this stage would be the acceptance by the RTA and relevant agencies of the locations where median widening is considered to be a reasonable and feasible alternative to aerial crossings for adoption as part of the detailed design of the Proposal.

2.2.2 Stage 2 – Finalisation and approval

This stage would involve finalisation and approval of median widening site/s recommended during Stage 1.

The RTA would conduct an environmental impact assessment of the changes to the approved project. A consistency assessment to determine if a modification of the Minister's conditions of approval would then be necessary pursuant to section 75W of the *Environmental Planning and Assessment Act, 1979*.

3. Feasibility assessment

As discussed in Section 1.2.2, the ecological investigations undertaken for the environmental assessment of the Proposal identified a number of locations where aerial crossing points would be required to facilitate movement of arboreal and glider species. These locations were selected during the development phase of the Proposal based on the recorded or likely presence of threatened and other aerial species, as well as habitat connectivity. Further information on the consideration and selection of these fauna crossing points is provided in the *Flora and Fauna Working Paper* (GHD 2010) in Volume 2 of the Environmental Assessment.

3.1 Workshop 1

The workshop was attended by senior RTA and GHD project team members with experience in project management, engineering design, environmental planning and environmental science. The selection criteria used to assess the feasibility of the possible median widening sites was based on the criteria used during the preferred route selection phase of the project. These criteria were grouped in three categories as environmental, social/community or engineering issues. The specific issues to be considered with regard to the individual selection criteria were also identified.

The criteria adopted for the assessment of feasibility of the median widening options are detailed in Appendix B.

As discussed in Section 1.2.2, the aerial crossing sites to be considered would be limited to the proposed glider crossing sites identified in the Environmental Assessment. There were two sites in Cairncross State Forest, two sites in Ballengarra State Forest, and one site in Maria River State Forest.

3.2 Desktop review

Based on the outcomes of this workshop, specialists within the GHD project team undertook a desktop review of the existing information collected for the development of the Proposal to identify the key features and issues for each potential median widening site. This desktop review also looked at the constraints and opportunities of each site with regard to the selection criteria.

A review of the concept design identified the fact that the carriageways would need to be realigned well beyond the area of the proposed glider crossing point. This additional realignment would be required to achieve the minimum road design standards for each carriageway while achieving the minimum desired length and width at the crossing site. As a result, the potential impacts at each crossing site would need to be assessed as set out in Table 3.

In a number of locations the existing data for the Proposal did not extend far enough to cover the additional area impacted by the median widening realignment. As the area of additional impact was generally fairly small, it was decided in this situation to extrapolate the existing data for the adjacent areas that are not currently impacted by the Proposal. Additional field survey

would then be undertaken as required during Stage 1 as set out in Section 2.2.1 to confirm the validity or otherwise of the extrapolation of the existing data for these additional areas of impact.

The details of this desktop review are shown in Appendix B.

3.3 Workshop 2

The workshop was attended by senior RTA and GHD project team members with experience in project management, engineering design, environmental planning and environmental science. This workshop considered the outcomes of the desktop review to help to identify the potential median widening sites that could be feasible for further investigation in Stage 1 of the assessment.

Following on from the desktop review, it was decided to revise the location and length of all of the potential median widening options due to the engineering (highway alignment) design requirements and the constraints identified. It was also considered appropriate to include some additional sites in the Ballengarra and Maria River state forests that may be better suited to the management of the potential barrier effects of the Proposal through widening of the median.

The details of the original and revised locations for the proposed glider crossing points are set out in Table 3.

Table 3 Locations of proposed glider crossing points subject to feasibility assessment

Name	As proposed in EA		Revised for assessment	
	Station	Length	Station	Length
Cairncross 1	10100 to 11150	1050 metres	10000 to 11600	1600 metres
Cairncross 2	11700 to 12225	525 metres	11500 to 12800	1300 metres
Ballengarra 1a	22600 to 23200	600 metres	22680 to 24000	1320 metres
Ballengarra 1b ¹	n/a	n/a	23200 to 23940	740 metres
Ballengarra 2	25075 to 25425	350 metres	24600 to 25780	1180 metres
Maria River 1a	34700 to 35775	1075 metres	34600 to 35160	560 metres
Maria River 1b ¹	n/a	n/a	33760 to 34380	620 metres

1. Alternative location proposed based on the concept design review. This location was not proposed in the Environmental Assessment.

This assessment was undertaken using the criteria identified in workshop 1 to help define the benefits and constraints of the potential median widening sites. For each of the selection criteria, key features were recorded at these locations based on known information and extrapolation of known information (Appendix B) to form the basis of the constraints analysis.

The level of constraint assigned across each of the assessment criteria for these seven sites is set out in Appendix C.

The key considerations impacting on the feasibility of median widening at each of these sites is summarised in Table 4 based on the following:

- The identified high or significant constraints (noting that negligible, low or medium constraints could be managed).
- The likely additional construction cost of the widened median relative to the existing concept design. The likely additional costs are a strategic estimate only based on key additional construction items and indicative additional property acquisition. A breakdown is provided in Appendix D.

This desktop assessment does not include a detailed evaluation of the constraints and opportunities of median widening at these sites. Nor does it include a detailed cost benefit analysis to determine the most cost effective solution for the project.

Table 4 Key considerations

Consideration		Glider pole location						
		Cairncross 1	Cairncross 2	Ballengarra 1a	Ballengarra 1b	Ballengarra 2	Maria River 1a	Maria River 1b
Significant constraints	Environment	--	--	Proposed fauna underpass	Proposed fauna underpass	Riparian habitat Tree height	--	--
	Community	--	--	--	--	--	--	--
	Engineering	--	--	--	--	Bridge / structures	--	--
High constraints	Environment	Habitat connectivity (to regional corridor) Endangered ecological communities Fauna habitat Groundwater dependent ecosystems	Regional corridor Endangered ecological communities Fauna habitat Groundwater dependent ecosystems	Regional corridor Vegetation clearing Endangered ecological communities Fauna habitat Riparian habitat Tree height	Regional corridor Riparian habitat Tree height	Regional corridor Endangered ecological communities	Regional corridor Proposed fauna underpass	Regional corridor Proposed fauna underpass
	Community	--	--	--	--	Noise	--	--
	Engineering	--	--	Earthworks Service road	--	Earthworks	--	--

Consideration		Glider pole location						
		Cairncross 1	Cairncross 2	Ballengarra 1a	Ballengarra 1b	Ballengarra 2	Maria River 1a	Maria River 1b
Additional construction costs	Key items	Acquisition (public) Structures Bill Hill Road overbridge	Acquisition (public and private) Structures Soft soils	Acquisition (public) Structures Barrys Creek Earthworks	Acquisition (public) Structures Barrys Creek Earthworks	Acquisition (public and private) Structures Mingaletta Road overbridge Barrys Creek realignment Noise treatment Earthworks	Acquisition (public) Structures Middle Gate Road overbridge Earthworks	Acquisition (public) Structures Earthworks
	Approximate additional cost estimate	\$3.0M	\$2.5M	\$5.0M	\$5.0M	\$4.0M	\$11.0M	\$11.0M

3.4 Discussion

Based on the key considerations in Table 4, the feasibility of median widening at each of the aerial crossing locations is discussed in Table 5.

Table 5 Feasibility assessment outcomes

Location	Discussion
Cairncross 1	- No private property would need to be acquired as this site would be wholly located within state forest. - Median widening at this location would require lengthening of the proposed Bill Hill Road overbridge resulting in some further ecological impacts. - Adequate separation of the realigned carriageways from the existing Pacific Highway would need to be maintained to provide a viable stand of vegetation. - There are two incidental fauna crossings proposed in this area that could require lengthening and the continued effectiveness of these for the target species requires further investigation. - Approximate additional cost estimate - \$3.0M.
Cairncross 2	- Median widening at this location would require further private property acquisition. - Potential to affect dwellings in close proximity as a result of noise and visual amenity impacts. - Soft soils exist in this location. - Additional clearing of regional wildlife corridor would be required to facilitate median widening at this location. - Additional clearing of endangered ecological communities would be required to the north of Cairncross State Forest. - Potential to impact regionally significant farmland. - Approximate additional cost estimate - \$2.5M.
Ballengarra 1a	- The existing trees are not likely to be high enough and glider poles could still be required between the service road and northbound carriageway in conjunction with widened median. - A dedicated fauna crossing at this location would require lengthening, potentially reducing its effectiveness. - The proximity of the service road to the west combined with the cuts and fills in this area constrain opportunities for realignment of carriageways without resulting in additional potentially significant impacts. - No private property would need to be acquired as this site would be wholly located within state forest. - Increased clearing of endangered ecological communities would be required. - Potential to impact upon hill climb track operation to the east. - Approximate additional cost estimate - \$5.0M.

Location	Discussion
Ballengarra 1b	• Would assist in movement of gliders in the northern section of Ballengarra State Forest. • Median widening at this location is constrained by the proposed service road to the west and extent of cuts and fills, potentially resulting in additional significant impacts. • No private property would need to be acquired as this site would be wholly located within state forest. • The existing trees are not likely to be high enough given the topography and glider poles could still be required between the service road and northbound carriageway in conjunction with widened median. • Median widening would also require lengthening of a dedicated fauna crossing and further investigation would be required to determine its continued effectiveness. • Potential to impact upon hill climb track operation to the east. • Extension through to approximately station 24600 would assist movement of predicted gliders in the northern section of Ballengarra State Forest. • Approximate additional cost estimate - \$5.0M.
Ballengarra 2	• Additional requirements for private property acquisition north of Ballengarra State Forest. • The existing trees are not likely to be high enough given the topography and glider poles could still be required between the service road and northbound carriageway in conjunction with widened median. • Significant engineering constraints (Mingaletta Road overbridge, service and access roads and rest areas). • Increased clearing of endangered ecological communities would be required. • Major realignment of Barrys Creek. • Additional clearing of endangered ecological communities and riparian habitat at Barrys Creek. • Potential to impact upon rural residences to the east. • Approximate additional cost estimate - \$4.0M.
Maria River 1a	• Median widening at this location could require design adjustments to the proposed Middle Gate Road overbridge, resulting in further impacts. • Two combined fauna crossings in this area could require lengthening and their continued effectiveness would require further investigation. • Maintaining adequate separation of the realigned carriageways from the existing Pacific Highway would be required to provide a viable stand of vegetation. • Existing trees could be high enough however, glider poles could still be required between the service road and northbound carriageway in conjunction with the widened median. • No private property would need to be acquired as this site would be wholly located within state forest. • Approximate additional cost estimate - \$11.0M.

Location	Discussion
Maria River 1b	• No private property would need to be acquired as this site would be wholly located within state forest. • One combined fauna crossing in this area could require lengthening and its continued effectiveness would require further investigation. • Further investigation is required to confirm that the surrounding vegetation is of sufficient height relative to the road level to provide the required glide distances. • Approximate additional cost estimate - \$11.0M.

4. Conclusion

Table 6 provides a summary of the outcomes of the feasibility assessment and identifies those sites which would require further investigation during stage 1. This information will be obtained as part of the stage 1 investigations described in Section 2.2.1.

Table 6 Conclusions

Location	Summary	Conclusion
Cairncross 1	As no private property acquisition would be required and given favourable topographical conditions, further consideration of median widening in this location is recommended.	Requires further investigation in consultation with agencies in stage 1.
Cairncross 2	Due to the additional private property and endangered ecological community impacts, median widening is not considered suitable at this location and glider crossings should be provided via proposed glider poles.	Median widening not considered feasible at this location.
Ballengarra 1a	Due to the height of existing trees, design limitations and endangered ecological community impacts, median widening is not considered suitable at this location and glider crossing should be provided via proposed glider poles.	Median widening not considered feasible at this location.
Ballengarra 1b	As no private property would be required and given fewer design constraints, further consideration of median widening in this location is recommended. Extension through to approximately station 24600 would assist movement of predicted gliders in the northern section of Ballengarra State Forest.	Requires further investigation in consultation with agencies in stage 1, with consideration of opportunities to improve glider movement in the northern half of Ballengarra State Forest.
Ballengarra 2	Due to the additional private property acquisition required, design constraints and endangered ecological community impacts, median widening is not considered suitable at this location and glider crossing should be provided via proposed glider poles.	Median widening not considered feasible at this location.
Maria River 1a	Due to the implications for the Middle Gate Road overbridge and other design constraints, median widening is not considered suitable at this location and glider crossing should be provided through the proposed glider poles.	Median widening not considered feasible at this location.
Maria River 1b	As no private property acquisition would be required and there are fewer design constraints. further consideration of median widening in this location is recommended.	Requires further investigation in consultation with agencies in stage 1.

5. Recommendations

This median widening assessment has considered the feasibility of widened medians at locations currently proposed for aerial fauna crossings (glider poles). The assessment carried out to date has not included a detailed evaluation of the constraints and opportunities of median widening at these sites. Nor has a detailed cost benefit analysis been undertaken to determine the most cost effective solution for the Proposal.

Based on this preliminary assessment, it is recommended that the following sites require further investigation to determine their suitability for median widening:

- ▶ Cairncross 1 (between station 10000 to 11600).
- ▶ Ballengarra 1b (between station 23200 to 23940).
- ▶ Maria River 1b (between station 33760 to 34380).

Further investigation of the above sites as part of the stage 1 and 2 assessments during the detailed design phase would include:

- ▶ Preliminary engineering design and cost analysis.
- ▶ Field investigations as necessary.
- ▶ Consultation with affected landowners.
- ▶ Consultation with relevant agencies.
- ▶ Analysis to qualify the benefits and impacts based on the preliminary designs.
- ▶ Confirmation of those sites where median widening would be feasible and reasonable.

Following completion of the above tasks, a workshop would be held, involving the RTA and relevant agencies to discuss the outcomes of the assessment.

Appendix A

Selection criteria

Category	Assessment criteria	Considerations (Widened median relative to existing concept design)
Environment	Vegetation clearing generally	Greater area of all vegetation clearing?
	Endangered ecological communities (EEC)	Greater area of EEC clearing?
	Threatened flora and fauna species – TSC and EPBC	Greater loss of recorded species?
	Fauna habitat	Greater loss of mapped “high value” habitat?
	Regional corridors	Would it create a larger barrier to mapped regional corridors?
	Fauna underpasses – would need to be lengthened	Assuming any underpasses would have to cross the widened median in addition to the main carriageways in one passageway, and that this is less desirable to most target species, would it create a greater barrier to fauna movement? Greater emphasis would be given to dedicated crossings, and less emphasis to incidental crossings.
	Fish passage - any bridges / major creeks?	Greater barrier / impact on fish passage?
	Groundwater dependent ecosystems (GDE)	Greater area of GDE clearing?
	Impact on riparian zones	Greater intrusion into / clearing in riparian zone?
	SEPP 14 wetlands, mangroves and seagrasses	Greater area of clearing?
	Need in that location – species recorded v likely v predicted	Not rated. Need has already been determined based on recorded species and habitats.
	Trees high enough?	Is the existing vegetation likely to be tall enough and located close enough to edges of carriageways (following clearing for the Proposal) for target glider species to safely glide across the separated carriageways to the widened median? Also need to consider whether upgraded highway is in cut or fill and presence of other adjacent barriers such as service roads.
Social/community	Proximity to dwellings – noise; visual	Would the realigned carriageway be closer to rural residences?

Category	Assessment criteria	Considerations (Widened median relative to existing concept design)
	Aboriginal heritage	Greater impact on known or high potential Aboriginal heritage sites?
	Non-Aboriginal heritage	Greater impact on known or high potential Non-Aboriginal heritage sites?
	Changes to property access	Greater impacts on public or private property access?
	Property acquisition	Greater public or private acquisition requirements?
	Impact on nature reserves and national parks	Greater acquisition from nature reserves or state forests?
	Impact on regionally significant farmland	Greater acquisition of mapped regionally significant farmland?
	Impact on state forests	Greater acquisition of productive state forest lands?
	Commercial / business impacts (other than state forests)	Greater impact on commercial businesses or activities?
	Impact on communities	Greater social impacts on communities?
	Impacts on land development potential	Greater constraints on development potential?
Engineering	Maintaining design speed	Can design speeds be achieved?
	Alignment	Can alignment design criteria be achieved?
	Impact on bridges, culverts, overbridges	Greater need for widening or redesign of structures?
	Reuse of existing assets eg existing carriageway	Less use of existing asset?
	Earthworks balance and magnitude	Impact on overall cut/fill balance?
	Flooding	Intrusion into flood zones?
	Drainage	Greater issues for overall road drainage?
	Service road location	Adjacent service / access road?
	Utilities	Greater impact on utilities?
	Soft soils	Greater intrusion into areas of soft soils or acid sulphate soils?
	Safety	Can road safety targets be achieved?
	Cost	Greater costs of construction?
	Capacity to stage	Is staging project staging still achievable?

Appendix B

Key features

Category	Assessment Criteria	Glider Crossing Location & Key Features					
		Cairncross State Forest			Ballengarra State Forest		Maria River State Forest
		Cairncross 1		Cairncross 2	Ballengarra 1a	Ballengarra 2	Maria River 1a
		st10100-st10500	st10500-st11150	st11700-st12225	st22600-st23200	st25075-st25425	st34700-st35775
Environment	Vegetation clearing generally	Yes	Yes	Yes	Yes	Yes	Yes
	EECs	None mapped. Possible but unlikely to the east.	Yes at northern end. Yes to west (at northern end) Yes to east.	Yes for majority of alignment. Yes to west (at nth & sth end) Yes all areas to east.	Yes to west (at northern end) No to east & west (otherwise)	Yes to east No to west	No
	Threatened flora and fauna species – TSC and EPBC	Yes in vicinity	Yes in vicinity	Yes in vicinity	Yes in vicinity (1)	Yes in vicinity	Yes in vicinity
	Fauna habitat	High	High	High/Medium	High (mostly) / Medium	High	High
	Regional corridors	SF linkage?	SF linkage?	SF linkage?	Regional (entire SF)	Regional (entire SF)	Regional (entire SF)
	Fauna underpasses – would need to be lengthened	Nil	Yes (1 at each end) (incidental)	Yes (1 at sth end) (incidental)	Yes (1 at nth end) (incidental)	Yes (1 at each end) (incidental)	Yes (1 at each end) (combined)
	Fish passage - any bridges / major creeks?	No.	No.	No.	No.	No. (but Barrys Creek immediately to east)	No.
	GDEs	None mapped. Possible but unlikely to the east.	Yes at northern end. Yes to west (at northern end) Yes to east. "Limited" (some) to west	Yes for majority of alignment. Yes to west (at nth & sth end) Yes all areas to east.	"limited" to west (at northern end) "unlikely" to east & west (otherwise)	"limited" to west some "limited" to west, otherwise "unlikely"	"unlikely" to east & west "limited" further east
	Impact on riparian zones	unlikely	unlikely	unlikely	Possible	Possible (Barrys Creek)	unlikely
	SEPP 14 wetlands, mangroves and seagrasses	No.	No.	No.	No.	No.	No.
	Need in that location – species recorded v likely v predicted	Predicted (habitat)	Predicted (habitat)	Predicted (habitat)	Predicted (habitat)	Recorded (YBG)	Predicted (habitat)
	Trees high enough?	Yes	Yes	Yes	Yes	Yes	Yes
Social / Community	Proximity to dwellings – noise; visual	1800m north east of nth end	1500m north east of nth end	660m to north west of nth end 920m east from nth end	800m from sth end	350m west from north end 450m north east / east from nth end	700m north west from nth end
	Aboriginal heritage	OHK 219/A	Nil known	AHIMS site approx. 350m east	Nil known	Nil known	Nil known
	Non-Aboriginal heritage	OHK7 tree stump to west of ex hwy	Nil known	OHK8 Drainage channels to nth	OHK3 Old Pac Hwy to east?	Nil known	Nil known
	Changes to property access	Nil private (may be some SF trails?)	Nil private (may be some SF trails?)	Nil private (may be some SF trails?)	Hill Climb track to east	Old Pac Hwy to west Mingaletta Road to east Accesses to west (opp Ming Rd)	Nil private Middle Gate Road (east & west)
	Property acquisition	Cairncross SF (east & west) Rawdon Ck NR (west) Nil private	Cairncross SF (east & west) Rawdon Ck NR (west) Nil private	Cairncross SF (east & west) Nil private	Ballengarra SF (east & west) Nil private	Ballengarra SF (east & west) Private land - nth end (east & west)	Maria River SF (east & west) Kumbatine NP (west) Nil private
	Impact on nature reserves and national parks	Unlikely (west of ex hwy)	Unlikely (west of ex hwy)	Nil	Nil	Nil	Unlikely (west of ex hwy)
	Impact on regionally significant farmland	Nil	Nil	Immediately nth of SF	Nil	Nil	Nil
	Impact on state forests	Yes (zones 3V, 4 & 8) seed trees?	Yes (zones 2, 4 & 8) seed trees?	Yes (zones 2, 4 & 8) seed trees?	Yes (zones 3V, 4 & 8)	Yes (zones 3A, 3V & 8)	Yes (zones 3V, 4 & 8)
	Commercial / business impacts	Forestry (zone 4)	Forestry (zone 4)	Forestry (zone 4) Tea Tree (north)	Forestry (zone 4) Hill Climb Track	Forestry (zone 4) Agricultural (north)	Forestry (zone 4)
	Impact on communities	Nil	Nil	Nil	Nil	Mingaletta Road	Nil
	Impacts on land development potential	Nil	Nil	Ag land to north?	Nil	Mingaletta Road	Nil

Category	Assessment Criteria	Glider Crossing Location & Key Features					
		Cairncross State Forest			Ballengarra State Forest		Maria River State Forest
		Cairncross 1		Cairncross 2	Ballengarra 1a	Ballengarra 2	Maria River 1a
		st10100-st10500	st10500-st11150	st11700-st12225	st22600-st23200	st25075-st25425	st34700-st35775
Engineering	Maintaining design speed						
	Alignment	Desirable minimum radii of R1200 has been used for curved alignment through this area. Therefore, NB curve remains as is and SB curve (inside) could be flattened to a larger radii to achieve section of widened median. Flatter curve for SB impacts on a straight section (min length) to south (Ch 10200 to 10300), that is between reverse curves. To overcome this, the dual carriageway alignment to the south will have to be realigned (moved) to the west to remove reverse curve. Therefore, total length of alignment impacted by median widening is guesstimated at 1400 m (Ch 10000 to 11400 - between 2 straight sections).		Desirable minimum radii of R3500 (+ 4% normal xfall - no super 0.5% longitudinal grade) has been used for curved alignment through this area. Therefore, SB curve remains as is and NB curve (inside) could be flattened to a larger radii to achieve section of widened median. Therefore, total length of alignment impacted by median widening is guesstimated at 1300 m (Ch 11500 to 12800 - between 2 straight sections). The widened median would be just inside forest area as centre of curve is ch 12140 - cleared area at ch 12250. We could have tighter curves (eg 2000) and apply super, but we had trouble with applying safe super transitions with the flat longitudinal grades of 0.5% - large flat area through super transition - ponding in rain.	In area where duplication of existing hwy - exist hwy is the NB carriageway. Adjust SB alignment only to achieve vege in widened median. No point in adjusting the NB carriageway as only netts road pavement UNLESS you do a major redesign and get SB over exist hwy and do switch to other side further north. Impact on Hill Climb Track on RHS. Major redesign and realignment to west would result in impact on SR and benched cutting. Having said that, SR would require realignment further to the west to achieve some exist vege between NB and the SR. SR would probably go up to next bench in cut at least. One very long curve(s) have been used through Cooperabung Range ch 20420 to 22680 (2.3 km) - a very tough section and was extremely difficult to design. Aim would be to stay out of these curves and do something with alignment north of ch 22680. If not you'll impact on 2.3 kms of design, involving deep cuttings and the Yarrabee Rd underpass bridges. To achieve widened median between 22600 to 23200 approx total length of alignment impacted would be 1320 m (22680 to 24000 - Barrys Ck). Much better location would be the curved alignment between ch 23200 to 23940 (R 300	Why are we trying to widen at this location? Rest areas left a right, Mingaletta Overbridge and very high fill embankments. There will be major clearing, lighting, noise and a traffic focal point. In area where duplication of existing hwy - exist hwy is the NB carriageway. Designed this way to take advantage of exist wide corridor to the north. So, adjust SB alignment only to achieve vege in widened median. Curved alignment between ch 24600 to 25780 (R 2460) could be amended by tightening the outside curve to achieve widened median around ch 25200, which is that area between the northern end of the NB rest area and the Mingaletta o'bridge. Turn the sed basin around so east/west and minimise vege clearing there will be vege between NB and the SR - 40 to 50 m wide. Major impact on Mingaletta o'bridge. Currently 64 m long - 3 spans. Would go to approx 100 m long and 5 spans. Realignment of SB curve would impact on Barrys Ck alignment, which runs parallel to SB on eastside around Mingaletta Rd.	Desirable minimum radii of R1200 has been used for curved alignment through this area ch 34600 to 35160. Therefore, SB curve (outside) has to remain as is and NB curve (inside) flattened to a larger radii to achieve section of widened median. Flatter curve for NB impacts on existing vege between carriageway and the existing hwy, which is about right with current design. To overcome this, the dual carriageway alignment between ch 34400 and 35400 would have to be realigned (moved) to the east to get realignment further away from exist hwy so inside curve could be flattened and maintain vege to exist hwy. Therefore, total length of alignment impacted by median widening could be as much as 1700 m (Ch 33700 to 35400) to achieve curve shift and maintain min straight sections between curves. Impact on overbridge for access to the Maria River State Forest (extra length) as flattened curve will commence north of the o'bridge. Why not do at curve at ch 33760 to 34380 (R 1200) where SB could be flattened to > R 1200 with min impacts? Target ch 34100 as wide median area?
	Impact on bridges, culverts, overbridges	Bill Hill Road overbridge	Minor drainage culverts	Minor drainage culverts	Barrys Creek and culverts	Barrys Creek and culverts	Middle Gate Road overbridge
	Reuse of existing assets eg existing carriageway	Yes	Yes	Yes	Yes	Yes	Yes
	Earthworks balance and magnitude	Minor cuts/fills	Minor cuts/fills	Minor fills	Major cuts/fills	Minor fills	Major cuts/minor fills
	Flooding	Above major flood area	Above major flood area	Above major flood area	Nil	Barrys Creek	Nil
	Drainage	to be determined	to be determined	to be determined	to be determined	to be determined	to be determined
	Service road location	Yes - ex hwy approx. 40m west	Nil	Nil	Yes - new road approx. 30m west	Yes - new road approx. 80m west Rest area to west	Yes - ex hwy approx. 40-60m west
	Utilities	Nil	Nil	Yes (to north)	Nil	Nil	Yes (east & south)
	Soft soils	Yes (to east)	Yes (to east)	Yes (to east(?) & north)	No	No	No
	Safety	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met	Minimum design standards will be met
	Cost	to be determined	to be determined	to be determined	to be determined	to be determined	to be determined
	Capacity to stage	Yes	Yes	Yes	Yes	Yes	Yes

Appendix C

Constraints analysis

Category	Assessment Criteria	Glider Crossing Location - ASSESSMENT																																							
		Cairncross State Forest						Ballengarra State Forest						Maria River SF																											
		Cairncross 1			Cairncross 2			Ballengarra 1a			Ballengarra 1b			Ballengarra 2			Maria River 1a			Maria River 1b																					
		EA station: st10100 to st11150			EA station: st11700 to st12225			EA station: st22600 to st23200			EA station: n/a			EA station: st25075 to st25425			EA station: st34700 to st35775			EA station: n/a																					
		Revised station: st10000 to st11600			Revised station: st11500 to st12800			Revised station: st22680 to st24000			Revised station: st23200 to st23940			Revised station: st24600 to st25780			Revised station: st34600 to st35160			Revised station: st33760 to st34380																					
Preliminary engineering: move southbound carriageway to the east						Preliminary engineering: move northbound carriageway to the west						Preliminary engineering: move southbound carriageway to the east. Need to keep north of Yarrabee Road traffic arrangement						Preliminary engineering: move southbound carriageway to the east.						Preliminary engineering: move southbound carriageway to the east.						Preliminary engineering: move northbound carriageway to the west.						Preliminary engineering: move northbound carriageway to the west.					
Environment	Vegetation clearing generally (total area)	Low	1		Low	1		High	3		Medium	2		Medium	2		Medium	2		Medium	2		Low	1																	
	EECs	High	3		High	3		High	3		Low	1		High	3		Negligible	0		Negligible	0		Negligible	0																	
	Threatened flora and fauna species – TSC and EPBC	Low	1		Low	1		Low	1		Low	1		Low	1		Low	1		Low	1		Low	1																	
	Fauna habitat	High	3	Habitat in median would not be useable for ground-based species.	High	3	Habitat in median would not be useable for ground-based species.	High	3		Medium	3		Medium	2		High	3		Medium	2		Medium	2																	
	Regional corridors	Medium - High	2.5	state forest containing contiguous native habitat, regional corridors in vicinity	High	3	state forest containing contiguous native habitat, regional corridor to east and west	High	3	regional corridor to east and west. Cooperabung Creek Nature Reserve to south.	High	3	regional corridor to east and west. Cooperabung Creek Nature Reserve to south.	High	3	regional corridor to east and west.	High	3	regional corridor to east and west.	High	3	regional corridor to east and west.	High	3	regional corridor to east and west.																
	Fauna underpasses – would need to be lengthened	Medium	2	2 incidentals, lengthening would further constrain movement	Medium	2	2 incidentals, lengthening would further constrain movement	Significant	4	1 dedicated, 1 incidental & 1 combined fauna crossing. lengthening would further constrain movement	Significant	4	1 dedicated & 1 incidental fauna crossing. lengthening would further constrain movement	Medium	2	3 incidental & 1 combined (at nthn end) fauna crossing. lengthening would further constrain movement	High	3	combined fauna crossings	High	3	combined fauna crossings	High	3	combined fauna crossings																
	Fish passage - any bridges / major creeks?	Negligible	0		Negligible	0		Medium	2		Medium	2		Medium	2		Low	1	actual creeks shown on topo	Low	1	actual creeks shown on topo	Low	1	actual creeks shown on topo																
	GDEs	High	3	same as EEC's	High	3	same as EEC's	Low	1		Negligible	0		Low	1		Negligible	0		Negligible	0		Negligible	0																	
	Impact on riparian zones	Low	1		Low	1		High	3		High	3		Significant	4	Barrys Creek	Low	1		Low	1		Low	1																	
	SEPP 14 wetlands, mangroves and seagrasses	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Need in that location – species recorded v likely v predicted			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			yellow belly glider observed to the north			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded			No rating - predicted to occur, but none recorded																
	Trees High enough or close enough?	Low	1	Road is in minor fill. Trees could be high enough	Low	1	Road is mostly in minor fill. Trees could be high enough	High	3	Road is in cut & fill. Adjacent service road to west also on fill. Trees probably not high enough.	High	3	Road is in cut & fill. Adjacent service road to west also on fill. Trees probably not high enough.	Significant	4	Road and service / access roads in cut & fill. Rest areas, Mingaletta Rd overbridge and Barrys Creek. Trees very unlikely to be high enough.	Medium	2	Road in cut & fill. Existing Pac Hwy to west. Trees could be high enough.	Low	1	Road in two large cuts with minor fill between. Trees could be high enough	Low	1	Road in two large cuts with minor fill between. Trees could be high enough																
Social / Community	Proximity to dwellings – noise; visual	Negligible	0		Medium	2	property owner refuses access	Negligible	0		Negligible	0		High	3		Negligible	0		Negligible	0		Negligible	0																	
	Aboriginal heritage	Low	1		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Non-Aboriginal heritage	Negligible	0		Low	1		Negligible	0		Negligible	0		Low	1	old pac hwy	Negligible	0		Negligible	0		Negligible	0																	
	Changes to property access	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Low	1		Low	1		Low	1																	
	Property acquisition	Low	1	Requires negotiation of forestry land	Low	1		Low	1		Low	1		Low	1		Low	1		Low	1		Low	1																	
	Impact on nature reserves and national parks	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Impact on regionally significant farmland	Negligible	0		Medium	2		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Impact on state forests	Medium	2	More harvestable land and zone 2 impact, seed trees likely avoided	Low	1	More harvestable land and zone 2 impact, seed trees likely avoided	Medium	2		Low	1		Medium	2		Medium	2		Medium	2		Low	1																	
	Commercial / business impacts other than state forests	Negligible	0	already considered forestry above	Low	1		Medium	2	Hill climb track	Medium	2	Hill climb track	Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Impact on communities	Negligible	0		Low	1	closer to Moorside Drive	Negligible	0		Negligible	0		Low	1		Negligible	0		Negligible	0		Negligible	0																	
	Impacts on land development potential	Negligible	0		Negligible	0	ref to LEP	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
Engineering	Maintaining design speed	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Alignment	Negligible	0		Low	1	(no superelevation due to long grade)	Negligible	0		Negligible	0		Negligible	0	Rest areas, sedimentation basins	Low	1	existing curve constraints	Negligible	0		Negligible	0																	
	Impact on bridges, culverts, overbridges	Medium	2	Bill Hill Road overbridge will require lengthening (another span?), culverts (and fauna crossings) lengthened	Low	1	minor drainage culverts	Medium	2	Barrys Creek and culverts	Medium	2	Barrys Creek and culverts	Significant	4		Medium	2	Middle Gate Road overbridge impacted	Low	1		Low	1																	
	Reuse of existing assets eg existing carriageway	Negligible	0	NA	Negligible	0	NA	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Earthworks balance and magnitude	Low	1		Low	1		High	3		Low	1		High	3	Barrys Creek	Medium	2		Medium	2		Medium	2																	
	Flooding	Negligible	0		Negligible	0		Negligible	0		Low	1		Medium	2	Barrys Creek	Negligible	0		Negligible	0		Negligible	0																	
	Drainage	Low	1	subject to impacts on vertical and horizontal alignment	Low	1	subject to impacts on vertical and horizontal alignment	Negligible	0		Low	1		Low	1		Low	1		Low	1		Low	1																	
	Service road location	Low	1	subject to design alignment and location	Negligible	0	NA	High	3		Negligible	0		Low	1		Low	1	service road constraint to west	Low	1	service road constraint to west	Low	1	service road constraint to west																
	Utilities	Low	1		Low	1	Optic fibre on eastern side	Negligible	0		Negligible	0		Negligible	0		Low	1	11kv and Telstra FO	Low	1	11kv and Telstra FO	Low	1	11kv and Telstra FO																
	Soft soils	Low	1	Also acid sulphate soils	Low	1		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
	Safety	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met	Negligible	0	Minimum design standards will be met																
	Cost			costs will increase as detailed above (bridges, land etc)			costs will increase as above (soft soils, land, drainage structures)			costs Higher (wider cuttings, bigger culverts across Barrys Creek)			costs Higher (wider cuttings, bigger culverts across Barrys Creek)			costs Higher (Barrys Creek, Mingaletta Road Bridge, land etc)			costs Higher (impacts on bridge, earthworks, culverts, fauna crossings, drainage)			costs Higher (impacts on bridge, earthworks, culverts, fauna crossings, drainage)																			
	Capacity to stage	Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0		Negligible	0																	
			28.5	0		0	33	0	0	39	0	0	31	0	44	0	0	28	0	0	22	0	0	22	0																

Appendix D

Strategic cost estimate – additional costs

Item	Strategic cost estimate (\$)						
	Cairncross 1	Cairncross 2	Ballengarra 1a	Ballengarra 1b	Ballengarra 2	Maria River 1a	Maria River 1b
Additional clearing	300000	300000	300000	300000	150000	350000	350000
Additional topsoil strip	64000	64000	64000	64000	30000	70000	70000
Additional pavement	Nil	180000	360000	360000	200000	Nil	Nil
Additional cut	520000	160000	1950000	1950000	390000	6682000	6682000
Additional fill	160000	400000	Nil	Nil	Nil	Nil	Nil
Additional barrier	80000	80000	80000	80000	60000	80000	80000
Fauna fencing	160000	160000	160000	160000	120000	160000	160000
Cross drainage	150000	126200	745700	745700	151300	236200	236200
Pavement drainage	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Bridge extension	640000	Nil	Nil	Nil	1968500	460000	460000
Public Utilities	50000	50000	Nil	Nil	Nil	Nil	Nil
Additional acquisition	75000	375000	100000	100000	200000	75000	75000
Sub Total	2199000	1895200	3759700	3759700	3269800	8113200	8113200
Contingency + 30%	659700	568560	1127910	1127910	980940	2433960	2433960
Total	2858700	2463760	4887610	4887610	4250740	10547160	10547160
Rounded Total	Say \$3.0M	Say \$2.5M	Say \$5.0M	Say \$5.0M	Say \$4.0M	Say \$11.0M	Say \$11.0M

Strategic cost estimate assumptions

Cairncross 1

- Clearing and mill to stockpile (state forest) - additional 60000 sq m @ \$5 sq m = \$300000
- Topsoil strip to stockpile - 6400 cu m @ \$10 = \$64000
- Pavement - Nil
- Cut - allow 10 wide x average depth 3m x 700m = 20000 cu m @ 26/cu m = \$520000
- Fill - allow 20m wide x 3m average depth x 400m = 24000 cu m - cut = 4000 import @ \$40/cu m = \$160000
- Barrier - 400m each side in median due to vegetation being closer. \$100/m = \$80000
- Fauna fencing - 400m each side @ \$200/m = 160000
- Cross drainage - assume 20m extension for No 32 and 32A:
 - No 32 - 1200 x 900 PCBC. \$2000/m. Assume 20m extension = \$40000
 - No 32 - 3000 x 2400 PCBC. \$5260/m. Assume 20m extension = \$105200
- Bill Hill Overbridge - assume 20m bridge extension + additional pier. 8m wide x 20m = 160 sq m @ \$4k sq m = \$640000
- Public utilities - optical fibre cable at Bill Hill Rd - additional impact. Allow provisional amount of \$50000
- Property acquisition – state forest - additional area of 20 (average) x 1600 = 32000 sq m. RTA property estimate + \$75,000

Cairncross 2

- Clearing and mill to stockpile (state forest) - adopt same as Cairncross 1 = \$300000
- Topsoil strip to stockpile - adopt same as Cairncross 1 = \$64000
- Pavement - additional pavement at emergency crossover 200 cu m x \$900 cu m = \$180000
- Cut - allow 10 wide x average depth 3m x 200m = 6000 cu m @ 26/cu m = \$160000
- Fill - allow average 20m wide x 2m average depth x 400m = 16000 cu m - cut = 10000 import @ \$40/cu m = \$400000
- Barrier - 400m each side in median due to vegetation being closer. \$100/m = \$80000
- Fauna fencing - 400m each side @ \$200/m = \$160000
- Cross drainage - assume 20m extension for No 32B and 33:
 - No 32B - 3000 x 2400 PCBC. \$5260/m. Assume 20m extension = \$105200
 - No 33 - 3/600 diameter RCPs. Assume 20m extension - 60m at \$350/m = \$21000
- Public utilities - optical fibre cable at Bill Hill Rd - additional impact. Allow provisional amount of \$50000
- Property acquisition – state forest - additional area of 20 (average) x 1100 = 22000 sq m.

RTA property estimate + \$75,000

- Property acquisition – private - additional area of $50 \times 50\text{m} + 25 \times 750 = 21250 \text{ sq m}$. RTA property estimate + \$300,000

Ballengarra 1a / 1b

- Clearing and mill to stockpile (state forest) - adopt same as C1 = \$300000
- Topsoil strip to stockpile - adopt same as C1 = \$64000
- Pavement - additional pavement at emergency crossover $400 \text{ cu m} \times \$900 \text{ cu m} = \$360000$
- Cut - 2 separate cuttings that will yield approx $75000 \text{ cu m} @ 26/\text{cu m} = \$1950000$
- Fill - additional fill required at northern end = $15000 \text{ cu m} = \text{nil cost as allowed in cut to fill above}$
- Barrier - 400m each side in median due to vegetation being closer. $\$100/\text{m} = \$80000$
- Fauna fencing - 400m each side @ $\$200/\text{m} = \$160000$
- Cross drainage - assume 20m extension for No 71, 72, 73, 74 and 75:
 - No 71 - $3000 \times 2100 \text{ PCBC}$ at $\$4955/\text{m}$. Assume 20m extension = $\$99100$
 - No 72 - $900 \times 600 \text{ PCBC}$ at $\$1495/\text{m}$. Assume 20m extension = $\$29900$
 - No 73 - 5 cell 3000×3000 at $\$20945/\text{m}$. Assume 20m extension = $\$418900$
 - No 74 - $3000 \times 1800 \text{ PCBC}$ at $\$4570/\text{m}$. Assume 20m extension = $\$91400$
 - No 75 - $3000 \times 2400 \text{ PCBC}$ at $\$5320/\text{m}$. Assume 20m extension = $\$106400$
- Overbridge - Nil
- Public utilities - nil
- Property acquisition - State Forest - additional area of 50 (average) $\times 1050 = 52500 \text{ sq m}$. RTA property estimate + \$100,000

Ballengarra 2

- Clearing and mill to stockpile (state forest) - short length $\times$ area = $\$150000$
- Topsoil strip to stockpile - smaller area than C1 = $\$30000$
- Pavement - additional pavement at for Mingaletta Rd $1000 \text{ sq m} \times \$200 \text{ sq m} = \$200000$
- Cut - cutting at southern end that will yield approx $15000 \text{ cu m} @ 26/\text{cu m} = \$390000$
- Fill - additional fill required at northern end = $15000 \text{ cu m} = \text{nil cost as allowed in cut to fill above}$
- Barrier - 300m each side in median due to vegetation being closer. $\$100/\text{m} = \$60000$
- Fauna fencing - 300m each side @ $\$200/\text{m} = \$120000$
- Cross drainage - assume 20m extension for No 75, 76 and 78:

- No 75 - 3000 x 2400 PCBC at \$5320/m. Assume 10m extension = \$53200
- No 76 - 1500 diameter RCP at \$1675/m. Assume 20m extension = \$33500
- No 78 - 3000 x 1500 PCBC at \$4305/m. Assume 15m extension = \$64575
- Overbridge - Mingaletta Overbridge extension - additional 30m span x 11m wide = 330 sq m at 5965/ sq m = \$1968500
- Public utilities - nil
- Property acquisition - state forest - additional area = 15000 sq m. RTA property estimate + \$50,000
- Property acquisition - private - additional area = 5000 sq m. RTA property estimate + \$150,000

Maria River 1a / 1b

- Clearing and mill to stockpile (state forest) - > C1 in area = \$350000
- Topsoil strip to stockpile - > area than C1 = \$70000
- Pavement - Nil. Emergency crossover has to be moved to the south
- Cut - 3 reasonable sized cuttings - 8000 + 136500 + 112500 cu m @ 26/cu m = \$6682000
- Fill - minor fill throughout = approx 10000 cu m = nil cost as allowed in cut to fill above
- Barrier - 400m each side in median due to vegetation being closer. \$100/m = \$80000
- Fauna fencing - 400m each side @ \$200/m = \$160000
- Cross drainage - assume 20m extension for No 102, 103 and 104:
 - No 102 - 3000 x 1800 PCBC at \$4570/m. Assume 20m extension = \$91400
 - No 103 - 3000 x 3000 PCBC at \$6190/m. Assume 20m extension = \$123800
 - No 104 - 3/600 diameter RCPs. Assume 20m extension - 60m at \$350/m = \$21000
- Overbridge - Access to Maria River State Forest - additional 10m span x 8m wide = 80 sq m at \$5750/ sq m = \$460000
- Public utilities - nil
- Property acquisition - state forest - additional area = 15000 sq m. RTA property estimate + \$75,000

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