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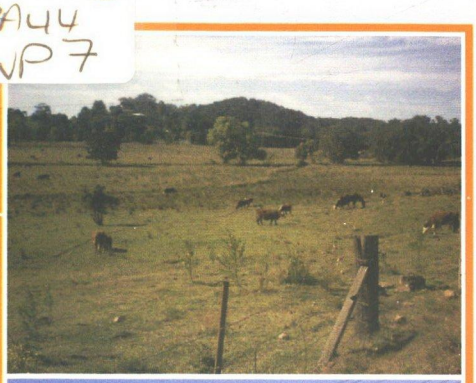

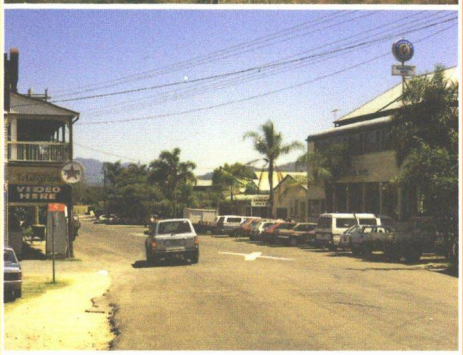

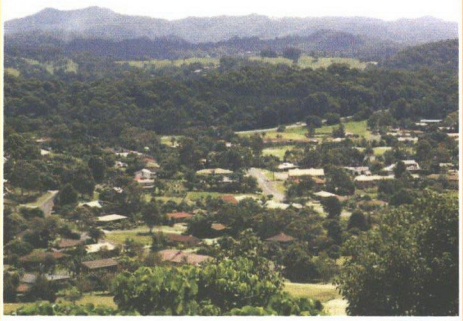

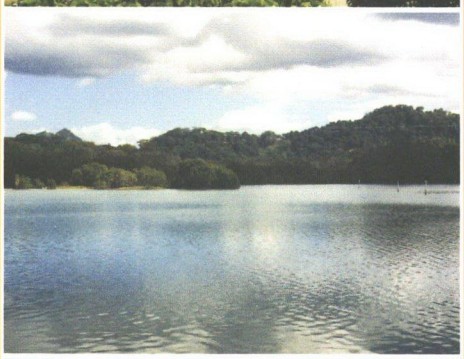

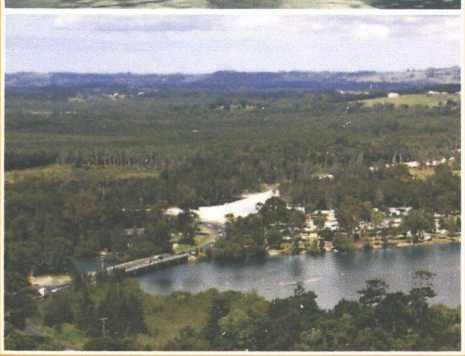

Proposed Duplication of the Brunswick Heads Bypass and Upgrade of the Pacific Highway Brunswick River to Yelgun

JULY 1998

Working Paper No. 7
Flora and Fauna Assessment

EIS

Environmental Impact Statement

RTA

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL DEVELOPMENT

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Proposed Duplication of the Brunswick Heads Bypass and Upgrade of the Pacific Highway Brunswick River to Yelgun

Environmental Impact Statement

Flora and Fauna Assessment
Working Paper No. 7

July 1998

***Note:** This Working Paper contains two parts. The first part comprises the Flora and fauna assessment which was prepared by Gunninah Consultants. The second part comprises a Fish Fauna Assessment which was prepared by The Ecology Lab.*

PROPOSED DUPLICATION of the BRUNSWICK HEADS BYPASS

and

UPGRADE of the PACIFIC HIGHWAY, BRUNSWICK RIVER to YELGUN

ENVIRONMENTAL IMPACT STATEMENT
Working Paper No 7

FLORA and FAUNA ASSESSMENT

July 1998

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PROPOSED DUPLICATION of the BRUNSWICK HEADS BYPASS
and
UPGRADE of the PACIFIC HIGHWAY, BRUNSWICK RIVER to YELGUN

ENVIRONMENTAL IMPACT STATEMENT
FLORA and FAUNA ASSESSMENT

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PROPOSED DUPLICATION of the BRUNSWICK HEADS BYPASS
and
UPGRADE of the PACIFIC HIGHWAY, BRUNSWICK RIVER to YELGUN

ENVIRONMENTAL IMPACT STATEMENT
FLORA and FAUNA ASSESSMENT

1 INTRODUCTION

1.1 BACKGROUND

The Roads and Traffic Authority (RTA) is proposing to upgrade the Pacific Highway north and south of Brunswick Heads, in northern NSW (Figure 1). The proposal[1] includes the construction and operation of a new dual carriageway between Brunswick Heads and Yelgun, and duplication of the Brunswick Heads Bypass (recently open to traffic) to the west of Brunswick Heads. A northern interchange will be constructed at Yelgun (about 1.7km north of Billinudgel) and a southern interchange will be constructed about 250m south of the Brunswick River. The proposal includes the construction of a new bridge over the Brunswick River, and the retention of the existing Pacific Highway (with some small additions) as a local road. The total length of the proposal is 8.7km.

The proposed upgrade of this section of the highway is part of the Pacific Highway Upgrading Program, which is a joint NSW State/Commonwealth Government initiative. The Program has committed some $2.2 billion over 10 years for upgrading of the Pacific Highway between Hexham and the Queensland border.

This Working Paper is one of a series that documents the detailed investigations conducted to assess the potential environmental impacts of the proposal. These Working Papers accompany the Environmental Impact Statement (EIS) which has been prepared by Sinclair Knight Merz (SKM), on behalf of the RTA. The EIS addresses the requirements of both Parts 4 and 5 of the EP&A Act, as discussed below.

1.2 THE PROPOSAL

The preferred route for the proposed upgrade, which is the subject of the EIS and was the subject of the detailed flora and fauna investigations described in this Working Paper, was selected following extensive investigation of a broad study area, community consultation and analysis of numerous route options.

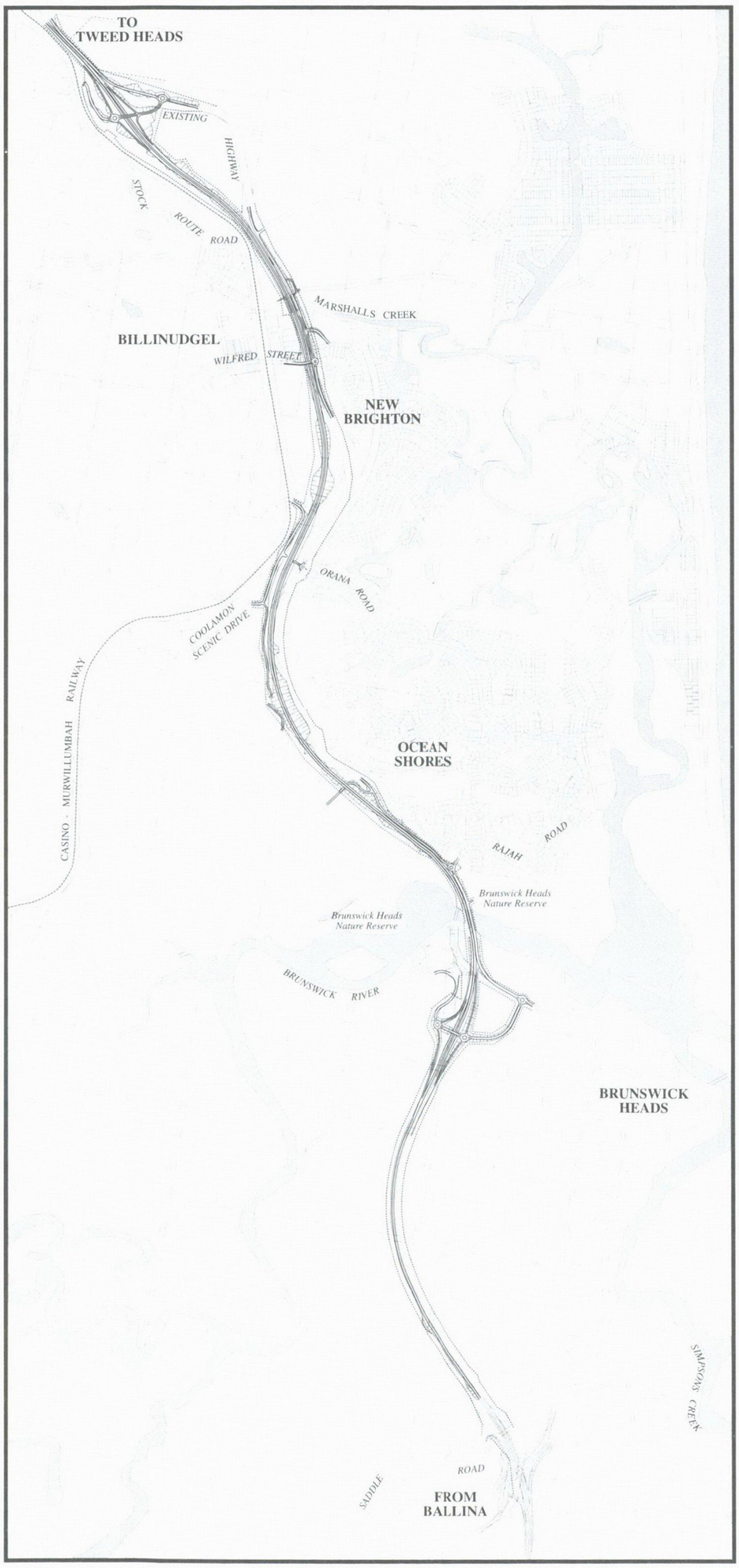
The preferred alignment (Route A2) commences at an interchange at the northern end of the existing Brunswick Heads Bypass, whence it heads northeast, intersecting the existing Pacific Highway. The proposed upgrade crosses the Brunswick River on a new bridge downstream of the existing Pacific Highway bridge, designed to carry 6 lanes of traffic - four lanes for the new dual carriageway, and two lanes for local traffic. The existing bridge will be demolished as part of the proposal.

---

[1] Proposal — The full upgrading of the Pacific Highway between the southern end of the Brunswick Heads Bypass, where it adjoins the Tandys Lane upgrade (south of Brunswick Heads), to Yelgun in the north, a distance of approximately 8.7km. The 'proposal' includes both the duplication of the existing Brunswick Heads Bypass (the southern portion of the proposal) and the construction of a new dual carriageway alignment from the northern end of the Brunswick Heads bypass (south of the Brunswick River) to Yelgun (in the north). The northern portion of the proposal is referred to as the proposed upgrade.

Duplication — The duplication of the existing Brunswick Heads Bypass of the Pacific Highway, located between the Pacific Highway south of Brunswick Heads (*ie* the northern end of the Tandys Lane Project) and the Pacific Highway bridge over the Brunswick River (northwest of Brunswick Heads). The duplication will involve the construction of a second two-lane carriageway immediately adjacent to and west of the existing Brunswick Heads Bypass.

Upgrade — The construction of a new dual carriageway along a new alignment between the northern end of the Brunswick Heads Bypass (south of the Brunswick River) and Yelgun (the northern extremity of the proposal). The upgrade will involve the construction of a four-lane, dual carriageway, high speed highway, predominantly along a new alignment between the northern and southern limits. This element of the proposal also includes modifications to and upgrading of the existing highway as a local access road, the construction of two major interchanges (one south of the Brunswick River and one at Yelgun), associated access roadworks and landscaping and rehabilitation programs.





Legend

..... Proposed Road Corridor

Figure 1
PROPOSED ROUTE ALIGNMENT

North of the Brunswick River, the proposal is generally located within the existing corridor road through the Brunswick Heads Nature Reserve, although some limited widening will be required. Development of the proposal would require revocation of a small part of the Nature Reserve.

North of the Brunswick Heads Nature Reserve, the proposal is generally located close to and west of the existing highway, north to Billinudgel. In the vicinity of Billinudgel, the proposal uses the existing highway as the southbound carriageway, with a new northbound carriageway to be constructed parallel and to the west. The old highway formation (pre-1981) will be reconstructed as the local road. The proposed upgrade would continue to a proposed interchange near Yelgun, with the carriageway passing to the east of Billinudgel.

Immediately north of the Yelgun interchange, the proposal would be located between the Billinudgel Nature Reserve and the railway, adjoining the existing highway. The RTA is currently undertaking investigations for the proposed upgrade from Yelgun to Chinderah, and it is anticipated that the EIS for the Yelgun to Chinderah section will be on exhibition in mid-1998. This proposal has been designed to be compatible with the Yelgun to Chinderah section of the highway upgrade.

The proposal includes retention of the existing highway facility as a local access road between Brunswick Heads and Yelgun. There will also be a need to relocate some short sections of the existing highway, in the vicinity of Rajah Road at Ocean Shores and at Billinudgel. Overall, there will be improved ease and safety of local access, as the proposal includes a new roundabout at Rajah Road, and a bridge over the proposed upgrade at Billinudgel to provide better access to Ocean Shores.

The proposal also includes duplication of the Brunswick Head Bypass, located to the west of Brunswick Heads, which was opened to traffic in June.

The proposal will be within a road corridor of variable width, from 60m to 100m (and wider in areas of deep cut). The corridor has been defined to allow for the road itself, as well as for landscaping and other environmental mitigation measures, including noise mitigation measures, erosion and sedimentation control, and fauna underpasses. A typical cross-section of the proposal is illustrated in Figure 2, indicating the layout of the local access and the proposed dual carriageway road.

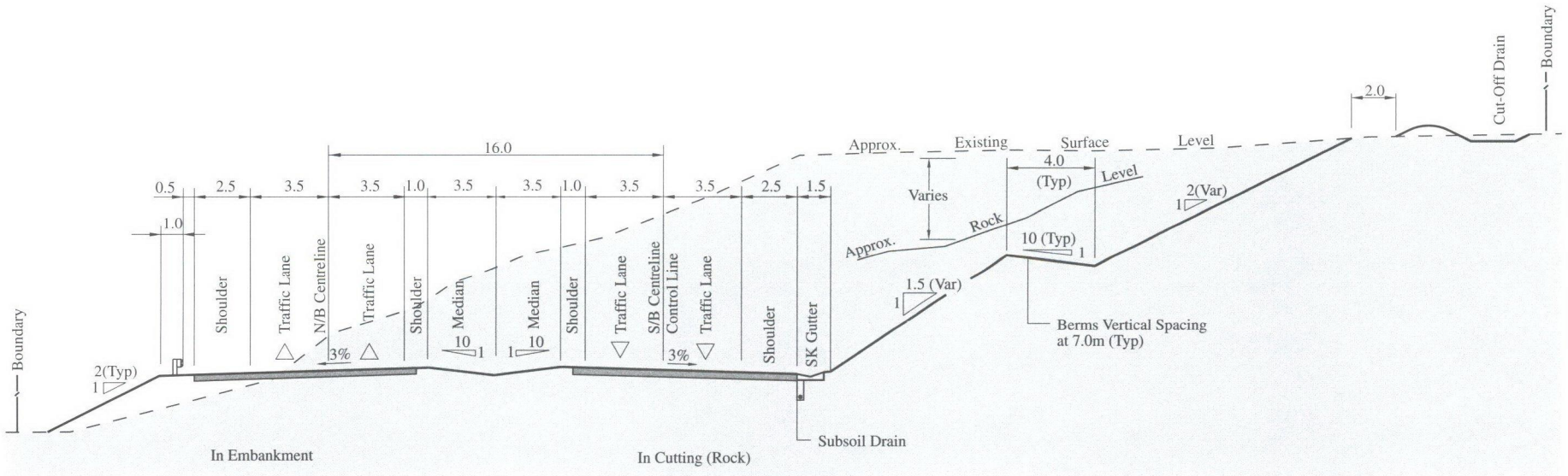
The description and assessment of the proposal provided in the EIS is based on a preliminary or concept design. For the purposes of this EIS, the design illustrates the general configuration of the proposal, and includes the location of interchanges, areas requiring cut and fill, local road re-alignments and a preliminary road profile.

Detailed design of the proposal will be undertaken if and when the RTA determines that the proposal is to proceed. The detailed design stage will use the concept designs and the information provided in this EIS with regard to environmental safeguards and mitigation measures, as well as submissions received as a result of the exhibition period, the RTA's determination and any conditions imposed.

1.3 ENVIRONMENTAL IMPACTS and MITIGATION MEASURES

The purpose of this environmental assessment is to identify potential impacts associated with the proposal, and to establish their significance. An important element of the process has been to identify the mitigation and environmental measures that need to be incorporated into the project to ensure that the environment can be adequately protected. The potential environmental impacts of the proposal are described in each Working Paper, and are described cumulatively in the EIS document. Additional environmental approvals and/or licences that would be required to enable the project to proceed are also identified in each Working Paper, and the EIS document.

The relevant environmental mitigation and management measures, together with statutory requirements, are to be collated in the form of a Project Environmental Management Plan (EMP), as discussed in Section 17 of the EIS document. That section of the EIS also includes an outline of the 'Environmental Safeguards' to be applied prior to, during and post construction of the proposal.



Legend

N/B	Northbound
S/B	Southbound

Figure 2
TYPICAL CROSS SECTION

1.4 FLORA and FAUNA ASSESSMENT

The region in which this portion of the Pacific Highway is located supports a relatively high diversity of habitats and of fauna and flora species as a result of high rainfall and rich soils, and because the region is located in the overlap zone of tropical and temperate climatic conditions. The NSW National Parks & Wildlife Service (NP&WS) describes the north coast of NSW as having the second highest level of biodiversity in Australia (exceeded only by the wet tropics), although this description applies to the 'North East Forests Biodiversity' region[2] as a whole (NP&WS 1992), not solely to the Brunswick Heads area.

The information obtained on biota in the study area includes:

- descriptions of the major vegetation types and their conservation significance;
- an assessment of the condition of vegetation communities in the area;
- known and potential occurrences of rare, endangered and vulnerable plant and animal species;
- the location of habitats or resources of special value to relevant threatened fauna and flora; and
- the extent of land dedicated for conservation purposes (such as SEPP 14 Wetlands and Nature Reserves).

Assessment of the biological conservation values in the vicinity of Brunswick Heads for this proposal is based on information from a variety of sources, including previous mapping and investigations, several databases (the NP&WS Wildlife Atlas; Birds Australia; NSW Bird Atlassers Inc), data and records from local residents and experts, several field inspections, and detailed fauna and flora investigations of the study area.

The proposal requires consideration of the potential impacts imposed by its construction and subsequent operation on the natural environment. In assessing the potential for environmental impacts, it is necessary to consider the effects of the proposal during both construction and operational phases on fauna and flora in general, and particularly on threatened species or communities of high conservation value, and their habitats.

1.5 LEGISLATIVE REQUIREMENTS

The proposal requires consideration under NSW environmental planning and conservation legislation, as part of the environmental impact assessment (EIA) process. The proposal is located entirely within the Byron Local Government Area (LGA) and is subject to the provisions of the Byron Local Environmental Plan 1988 (LEP 1988) and of *State Environmental Planning Policy No 4 - Development Without Consent* (SEPP 4). Under the provisions of the LEP and of SEPP 4, the proposal does not require development consent by Council. Consequently, it will be considered under Part 5 of the *NSW Environmental Planning & Assessment Act 1979* (EP&A Act).

However, the proposal does involve disturbance to two *State Environmental Planning Policy No 14* - Coastal Wetlands (SEPP 14) sites, involving wetlands numbers 62 and 65 on the northern and southern sides of the Brunswick River. In accordance with the provisions of SEPP 14, those portions of the proposal which affect the SEPP 14 Wetlands are 'designated development', and require development consent from Byron Council. In providing development consent to the disturbance of SEPP 14 Wetlands, Council requires the concurrence of the Director-General of DUAP. Development consent by Council is determined under Part 4 of the EP&A Act.

The development application for disturbance to SEPP 14 Wetlands will be prepared in

---

[2] The 'North East Forests Biodiversity' region is an area in northeastern NSW which has been investigated in detail for fauna and flora biodiversity by the NP&WS (1994). The NEFBS study area includes 7.9 million hectares of northeastern NSW, bounded by the Queensland border in the north, the Hunter River in the south, the Pacific Ocean in the east and the New England Highway (approximately) in the west. This area conforms to the NSW North Coast and New England Tablelands regions of the Interim Biogeographical Regionalisation for Australia (IBRA), prepared by the Australia Nature Conservation Agency (now Environment Australia) in 1995. The NEFBS study area includes the coast and coastal plain, coastal ranges and foothills, the Great Escarpment and associated elements of the Great Dividing Range, and the northern tablelands.

accordance with Part 4 of the EP&A Act and lodged with Byron Council as the consent authority at the time of display of the EIS for the proposal. The decision of Council with respect to development consent for the SEPP 14 Wetlands will be included in the representations report of the RTA (under Part 5 of the EP&A Act) which is to be forwarded to the Minister for Urban Affairs & Planning for approval.

As noted above, the proposal is generally subject to the provisions of SEPP 4, and development consent from Council is not required (with the exception of the SEPP 14 Wetlands discussed above). The proposal is subject to the provisions of Part 5 of the EP&A Act, which requires approval from the Minister for Urban Affairs & Planning and subsequent determination of the proposal by the Chief Executive of the RTA. As indicated in Section 111 and 112 of the EP&A Act, the determining authority (*ie* the RTA) is obliged to "*examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*", and to consider whether the proposal "*is likely to significantly affect the environment*".

The *Native Vegetation Conservation Act 1997* (NVC Act) requires consent from the Minister for Land & Water Conservation for the clearing of native vegetation in NSW. Under s.9 of the NVC Act, however, land to which SEPP 14 and "*land that is dedicated or reserved under the National Parks & Wildlife Act 1974*" is excluded from operation of the Act. Additionally, s.12 of the NVC Act indicates that "*any clearing that involves the removal or lopping of any tree or other vegetation in accordance with Section 88 of the Roads Act 1993*" is excluded from the operation of the Act. Section 88 of the *Roads Act 1993* states that:

> "*A roads authority may, despite any other act or law to the contrary, remove or lop any tree or other vegetation that is on or over-hanging a public road if, in its opinion, it is necessary to do so for the purposes of carrying out road work or removing a traffic hazard*".

On this basis, it would appear that the NVC Act does not apply to the proposed activity. Where the NVC Act does apply to the clearing of native vegetation, development consent is required under Part 4 of the EP&A Act from the Minister for Land & Water Conservation.

Because the project involves joint funding by the Commonwealth Government, Commonwealth planning and conservation legislation requires consideration. Where a project triggers both Commonwealth and State EIA processes (such as this proposal), arrangements have been developed between the Commonwealth and the States to avoid duplication by facilitating the joint assessment of proposals. Wherever possible, the requirements of both governments will be satisfied through the preparation of one document under the EIA process of the respective state or territory government (*Environment Protection (Impact of Proposals) Act 1974* (Cth): *Administrative Procedures* cl.12.2.1). This process accords with the principles contained in the *Intergovernmental Agreement on the Environment* 1994 (IGAE), and the Australian & New Zealand Environment & Conservation Council's "*Basis for a National Agreement on Environmental Impact Assessment*" (ANZECC 1992).

With respect to threatened biota, the potential effects of the proposal need to be considered at a state level by addressing Section 5A of the EP&A Act. Section 5A was created by amendments to the EP&A Act contained in the *NSW Threatened Species Conservation Act 1995* (TSC Act), which require that a consent or determining authority consider "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*" as a result of the proposed development. Section 5A of the EP&A Act provides eight factors which must be considered by the consent or determining authority in their administration of Sections 77, 90 and 112 of the EP&A Act. Where a development or activity is likely to impose "*a significant effect*" on threatened biota or their habitats, a Species Impact Statement (SIS) must be prepared, in accordance with Section 109, 110 and 111 of the TSC Act.

To satisfy Commonwealth EIA processes with respect to threatened biota, due consideration must also be given to species of national conservation concern listed under the *Commonwealth Endangered Species Protection Act 1972* (ESP Act). The potential effects of the proposal on threatened species listed under the ESP Act are discussed by reference to Section 5A of the EP&A Act in the relevant sections of this report.

Other elements of environmental impact legislation in NSW need to be addressed for the proposal. A number of environmental planning instruments have been generated under the

EP&A Act, including several State Environmental Planning Policies (SEPPs) which are of relevance to the proposal. SEPPs which are of relevance, and which are considered in Chapter 6, include:

- *State Environmental Planning Policy No 14 - Coastal Wetlands* (SEPP 14);
- *State Environmental Planning Policy No 26 - Littoral Rainforests* (SEPP 26); and
- *State Environmental Planning Policy No 44 - Koala Habitat Protection* (SEPP 44).

The Australian Government has signed agreements with the Governments of China and Japan with respect to the protection of migratory birds common to Australia and these countries. The China-Australia Migratory Birds Agreement (CAMBA.[3]) and the Japan - Australia Migratory Birds Agreement (JAMBA[4]) involve a desire "*to co-operate in the protection of migratory birds and their environment*". The Agreements include provisions for "*birds for which there is reliable evidence of migration between the two countries*", and involve measures relating to the taking of birds and their eggs, the purchase or exchange of birds, and the hunting of migratory birds. Eighty-one bird species are listed in CAMBA and 76 species are listed in JAMBA.

Whilst JAMBA and CAMBA impose some responsibilities on the Commonwealth and State Governments with respect to migratory birds, there is no enabling legislation at either the national or state levels for the implementation of these international Agreements. Thus, there is no legislative requirement to avoid the potential for the imposition of impacts upon species listed in JAMBA or CAMBA, nor to protect habitats for these species. Nevertheless, the proposal has been cognisant of JAMBA and CAMBA species, and both the route selection process and the subsequent design of the preferred option (Route A2) has involved consideration of the potential for impacts to be imposed upon these species and their habitats.

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[3] CAMBA - Agreement between the Government of Australia and the Government of the People's Republic of China for the protection of migratory birds and their environment.

[4] JAMBA - Agreement between the Government of Australia and the Government of Japan for the protection of migratory birds and birds in danger of extinction and their environment.

2 ROUTE SELECTION

As the decision has been made to upgrade the Pacific Highway between Hexham (near Newcastle) and the Queensland border (the Pacific Highway Upgrading Program), it is necessary as a first step to determine the most appropriate route for the upgrade, on the basis of minimising environmental impacts and maximising environmental benefits (including biological, physical, social and economic aspects of the environment). From the biological perspective, an array of field investigations and desk-top studies have been conducted to determine the biological constraints to possible locations for the road, and to contribute to the route selection process.

As noted above, the proposal comprises two distinct elements, being the duplication of the existing Brunswick Heads Bypass (which was the subject of a previous EIS - RTA 1993) and the upgrade of the Pacific Highway along a new alignment between the northern end of the Bypass (south of the Brunswick River) and Yelgun to the north.

The Brunswick Heads Bypass duplication is to involve the construction of a second two-lane carriageway immediately to the west of the existing completed carriageway. The portion of the proposed upgrade between the northern end of the Bypass and Yelgun has involved an extensive route selection process, because there was no clear acceptable route (DUAP & RTA 1996). The remainder of this section of the Flora & Fauna Assessment report is dedicated to consideration of the route selection process and possible alignments of the proposed upgrade between the northern end of the Brunswick Heads Bypass and Yelgun.

2.1 THE PROCESS

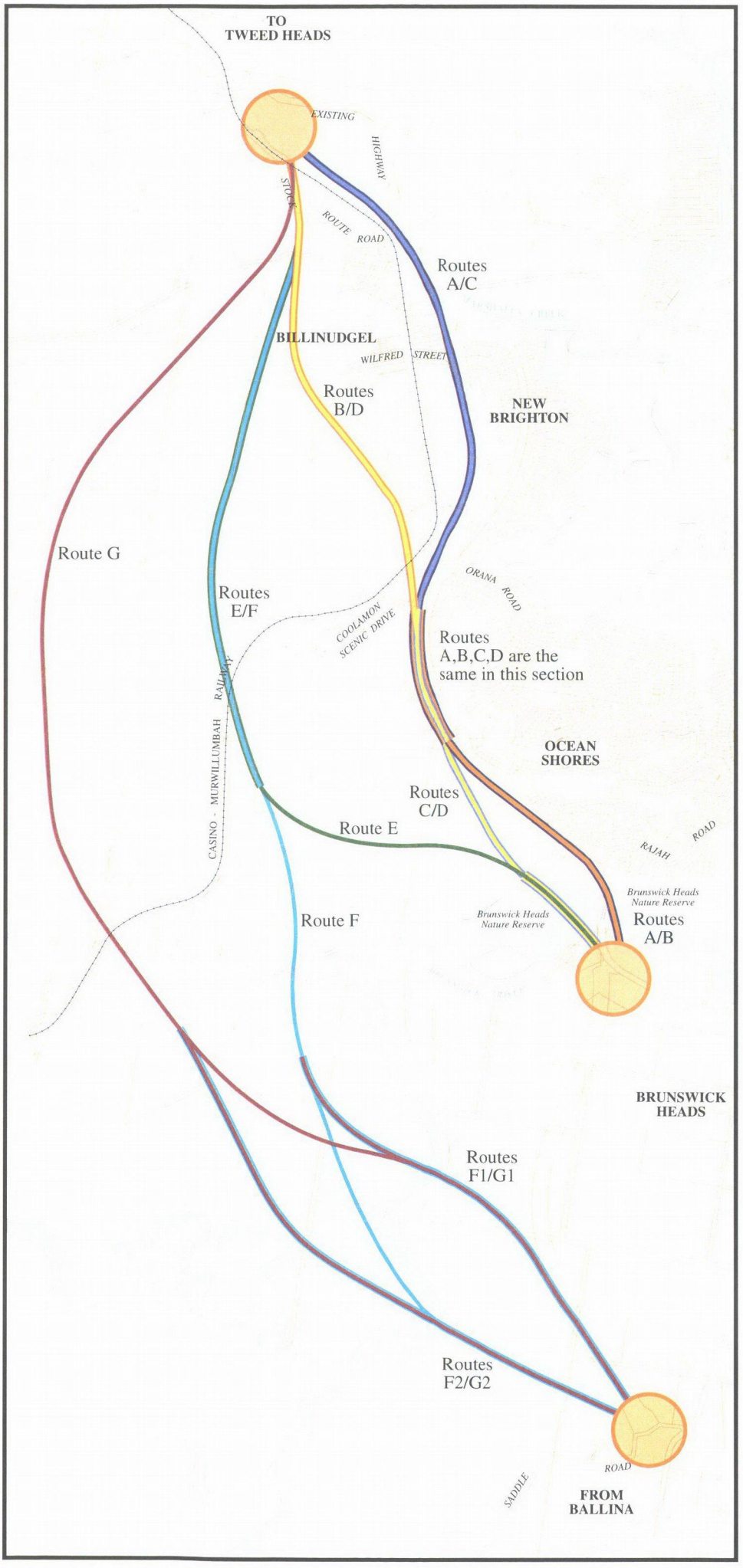
Assessment of the biological constraints to the location of an upgrade alignment between Brunswick Heads and Yelgun initially involved the identification of an appropriate 'study area' for the project, which provided a number of options for the alignment and within which investigations were to be conducted. The initial study area (Figure 3), involved a band up to 5km in width which included five initial route options (options A to E).

Subsequent consideration of the proposed upgrade in this locality by local residents resulted in several additional potential route options being proposed. Additional options were identified to the west of the original study area, involving route options F and G, and additional unspecified options further west (Figure 4). Consequently, the 'study area' designated for the project includes the lands between the existing highway and Option G in the west (Figure 4).

The process of evaluating the various route options has involved desk-top research and field investigations, and application of an evaluation process to determine the relative conservation values of the various options. Thus, all of the route options which were originally identified, as well as additional options promoted by local residents and others, have been accorded similar levels of field investigation and literature search, and have been considered using the same processes and procedures.

The purpose of the route selection phase of the biological investigations for the proposed upgrade is to provide general information on the broad-scale (landscape) values of sites in the study area and specific detailed information of some features to determine the biological constraints to the location of the proposed highway upgrade within the study area. The information collated and collected is intended to enable the identification of potential routes for the proposed upgrade which avoid or minimise adverse impacts upon:

- plant communities of high conservation value;
- vegetation communities and stands of high quality;
- plant species recognised as rare, vulnerable or endangered (threatened) under State and Commonwealth legislation;
- known and/or predicted locations of habitats and resources of significance for threatened species; and
- land dedicated for conservation purposes.





Legend

- Proposed Locations for Interchanges
- Route A
- Route B
- Route C
- Route D
- Route E
- Route F
- Route G

Figure 3+4
INITIAL (A-E) AND SUBSEQUENT ROUTE OPTIONS (F, G) CONSIDERED

Subsequent elements of the process for determining the preferred route for the Brunswick Heads to Yelgun portion of the proposed upgrade involved a two-day Value Management Workshop (VMW). The Workshop included a wide range of stakeholders (government departments, local residents, conservations groups *etc*) and an array of public displays and meetings with residents and community groups regarding the potential impacts of various options. Subsequent to this extensive consultative process and detailed biological (and other) investigations conducted throughout the study area, a preferred alignment was selected and recommended to the Minister of Roads.

2.2 SURVEY METHODS and ROUTE SELECTION PROCESS

Field investigations of fauna and flora have been conducted throughout the study area since 1992. Previous investigations of the biota and fauna and flora habitats within the study area have included studies by Milledge & McKinley (1992), Kinhill (1996), and the detailed field investigations conducted for the route selection process and the EIS for this project. Data from these field investigations, as well as database records and published information, have been utilised to determine the likely biological constraints to the location of the proposed upgrade and the duplication of the existing Brunswick Heads Bypass.

The route selection process focuses primarily on the consideration of major biological constraints within the study area (*eg* large tracts of forest, wetlands *etc*), although the locations of threatened plants were of concern and have been addressed in some detail. The size of the study area and the considerable array of threatened fauna and flora which occur within it require that a 'landscape approach' (which considers larger stands of vegetation and the distribution of habitats and resources through the locality) be applied in the first instance to determine biological constraints. The identification of individual plant species or specific resources is subsequently applied as a constraint once the initial potential routes have been identified.

The array of rare, vulnerable and endangered plant species which are known to occur in the study area are of particular relevance, because such species are widely distributed throughout the study area. It is considered extremely unlikely that any route for the proposed upgrade between Brunswick Heads and Yelgun could be identified which would avoid all specimens of all rare or significant plant species. Even if such a route does exist, substantial environmental degradation of areas of vegetation and wildlife habitats would be likely as a result. Furthermore, threatened fauna and flora species are not always confined to large intact areas of natural vegetation, and numbers of such species are known to occur within agricultural lands and in regenerating weed-infested forest communities.

Notwithstanding the above considerations, the process of assessing the study area from a general to a more detailed level with respect to fauna and flora is intended to ensure that impacts of major and potential significance on the biological environment are avoided in the route selection process. This approach adopts and implements the 'precautionary principle', by avoiding "*threats of serious or irreversible environmental damage*" and by applying "*measures to prevent environmental damage*".

Further detailed investigation of the preferred route selected, as part of the EIS process for that route (documented in subsequent portions of this report), have enabled identification of specific resources, habitats or species of high significance along the proposed alignment. The proposal design and the proposed engineering activities for the project have involved input with regard to features of biological relevance, further minimising the potential for adverse impacts upon the natural environment. Additionally, detailed impact amelioration, engineering and design measures, including plant propagation, engineering and stormwater run-off protocols, and compensatory habitat measures, will be incorporated into the final design and implementation of the project.

The original study area for the proposed upgrade of the Pacific Highway[5] is located between the northern end of the Brunswick Heads Bypass (south of the Brunswick River) and Yelgun in the north. The original study area was located between Route Option A and Route Option E (Information Sheet No 2 - March 1997), with five alternative Route Options provided (Figure 3).

[5] As noted above, the southern part of the project involves the duplication of the existing Brunswick Heads Bypass, by the addition of a second two-lane carriageway immediately to its west.

Supplementary investigations of other areas to the west and southwest were undertaken, to assess alternative route options raised by the local community. Alternative route options, including deviations from the southern end of Brunswick Heads Bypass or from the central part of the Bypass, crossing the Brunswick River between Kings and Midjimbil Creeks, and passing through the Hilans Corner area, were proposed (Route Options F and G). These route options extended the study area substantially to the west (Figure 4), and also required reconsideration of areas between the existing Brunswick Heads Bypass and the Brunswick River.

Field Investigations

The original study area was inspected for the route selection process by the biological investigation team on a number of occasions. Field investigations were conducted between the 17th and 19th of December 1996 (inclusive), and on the 21st of January 1997. Following these initial surveys, supplementary investigations were conducted on a variety of sites and occasions, providing a mosaic of information (particularly on vegetation community distributions and on the locations of threatened plants) for the extended study area (Appendix 10).

During the field inspections, sufficient information was obtained to describe the structure of the vegetation communities present (Specht 1970) and the dominant species characterising them, as well as to document occurrences of threatened or significant plant species. The degree of disturbance (tracks, weed-infestation *etc*) was also noted.

Supplementary field investigations for native fauna and flora were conducted both in the original and extended study areas, particularly to the west of Route Option E and in areas on the western side of the Brunswick River which had not previously been investigated. Additional field studies were required to determine the nature and condition of vegetation communities present along Route Options F and G, the relevance of vegetation communities for threatened fauna (particularly for the Koala), and the location and identity of threatened flora species in the vicinity.

The supplementary investigations followed similar protocols as the original studies, with driven and walked transects through vegetation communities, searches for threatened plant species or species of conservation significance, and searches for the presence of threatened fauna species, indirect evidence of their occurrence in the area, and identification of habitat or resource features.

As for the original study area, field investigations in the extended study area did not include the preparation of comprehensive species inventories, but were based on vegetation community descriptions, the condition of vegetation (weed-infestation, previous disturbance, edge-effects *etc*), and the presence of indirect evidence for threatened fauna species (*eg* scats, scratches) and of relevant resources (food trees, hollow-bearing trees *etc*).

Mapping of the vegetation communities and the condition of vegetation was carried out using 1:8000 colour aerial photographs (where available), with interpretation being aided by the field surveys and inspections. Substantial areas of remnant natural vegetation within the study area were mapped, although small highly degraded patches were omitted.

2.3 FLORA and FAUNA

The investigations of fauna and flora throughout the study area provide descriptions of an array of vegetation communities, and of the locations of threatened flora and fauna species. These constitute the basis for determining the conservation value of various areas, and for identifying potential biological constraints to the location of the proposed upgrade.

The fauna and flora investigations conducted for the route selection process were, as noted above, relatively broad scale, although they did provide sufficient detail for determining the biological constraints to the location of the proposed upgrade.

The field investigations of fauna and flora conducted for the route selection process were subsequently incorporated into the investigations and detailed reporting of fauna and flora conducted for the EIS and SIS associated with the preferred route option (Route A2). The

detailed descriptions of fauna and flora and vegetation communities within the study area and along Route A2 are provided in Sections 4 and 5 of this report. Similarly, details of the vegetation communities, and fauna and flora species of conservation significance, are provided in later sections of this report.

As is clear from the information which has been collected, and the extensive mapping and reporting provided, the study area supports a considerable array of vegetation communities, fauna habitats and resources for native fauna and flora. Some nineteen different vegetation communities have been identified and described in this report, and the conservation significance of individual vegetation communities has been determined (Section 3). As indicated in Section 2.4, the conservation significance of certain vegetation communities has been identified as a biological constraint to the location of the proposed upgrade.

A number of plant species of conservation significance were identified in the study area, which also imposes biological constraints to the location of the proposed upgrade. The presence of an individual or a small group of an Endangered plant species (*eg* the Hairy Quandong) imposes a primary constraint, given these species' high conservation status and extremely limited distribution in the region and locality. Vulnerable plant species, being generally more widespread and common in the locality and thus of relatively lower conservation concern, impose a lesser constraint to the location of the proposed upgrade. Details of the plant species of conservation significance (at Commonwealth, State, regional and local levels) are provided in Section 4 of this report.

Similar considerations apply to threatened fauna species. A number of threatened fauna are known to occur in the general locality, and several species have been recorded within the extended study area. Threatened fauna species also constitute a constraint on the location of the proposed upgrade, as do relevant habitats and resources for fauna species in the vicinity.

In this regard, the presence of threatened fauna species and of resources and habitat features of relevance has been incorporated into the constraints analysis for location of the preferred route for the proposed upgrade. Details of the threatened fauna known to occur in the study area, and their relevant resources and habitat features, are provided in Section 5 of this report.

2.4 ENVIRONMENTAL ASSESSMENT

The biological environment in the Brunswick area provides a number of environmental constraints to the potential alignment for the proposed upgrade. Constraints on the proposed alignment relate to vegetation communities (their condition and significance), fauna and flora species (particularly threatened species, as listed on the TSC Act, known or likely to occur in the area), and fauna movement corridors (particularly for species such as the Koala). In addition, the presence of two Nature Reserves and several SEPP 14 wetlands in the study area present potential constraints to the location of possible alignments.

Each of the elements of the biological environment which contribute to the conservation value of portions of the study area, and therefore to the constraints which may be imposed upon the potential alignments for the highway upgrade, can be ranked in terms of their conservation value and the potential for the proposed upgrade to impose significant adverse impacts upon them. The investigations detailed above, and documented elsewhere in this report, provide the basis for assessing the conservation significance of areas, communities and species within the study area. This enables the determination of a prioritised ranking for these elements of the biological environment in terms of the imposition of constraints on the proposed highway upgrade. This assessment is provided on the basis of the potential alignments (Route Options A to G), and with respect to particular evaluation criteria.

Evaluation Criteria

For assessing the conservation value of sites and features, threatened species and project features for the proposal, on a local, regional, state and national basis, eight criteria relating to ecological and conservation values are generally applied.

The eight criteria include:

- Size
- Representativeness
- Rarity
- Diversity
- Naturalness
- Connectivity
- Fragmentation
- Management

- **Size**

In the absence of other variables and habitat features, a larger patch of vegetation or habitat is considered of greater conservation value than a smaller one.

- **Representativeness**

Patches of habitat or vegetation communities which support a more representative suite of fauna and flora species (characteristic of the particular vegetation community) are accorded higher conservation value than those with a less comprehensive representation of biota. Representativeness may also refer to how well the patch of vegetation or community represents that vegetation type in the locality.

- **Rarity**

Rarity involves two elements - the presence of threatened or rare species within the habitat patch or vegetation community, and the rarity of the vegetation community or habitat patch with respect to its local, regional, state and national distribution.

In the first instance, patches of habitat or vegetation communities which support threatened species are accorded a higher conservation value than those which do not, and those with a greater number of threatened species are of greater conservation value. In the second instance, patches of a vegetation community which is rare are generally accorded a higher conservation value than patches of a vegetation community which is common or widely distributed.

- **Diversity**

Areas which support greater diversity are generally accorded greater conservation value than those with a more simple structure and biota. However, comparisons of levels of diversity must recognise the inherent differences between vegetation communities and habitat types. Consequently, diversity is a more relevant assessment criterion for comparing areas of the same vegetation type or habitat than for comparing different habitat types or communities across the landscape.

- **Naturalness**

The condition or naturalness of vegetation communities and habitat types is also of relevance in assigning conservation value. Areas of vegetation which have remained in an essentially natural condition for a longer period (*eg* old-growth forests in New South Wales) are accorded higher conservation value than those which have been disturbed or are regenerating from previous activities (*eg* grazing and clearing). Thus, areas which are remnant vegetation (*ie* have remained essentially intact despite some level of disturbance) rather than regrowth (*ie* regenerating after past clearing) are generally regarded as having a higher conservation value. Similarly, areas which are currently in good condition (*ie* with relatively less disturbance and weed infestation) are accorded a higher conservation value than those which are currently degraded. Areas characterised by weed species can, however, have conservation value as resources for certain species.

- **Connectivity**

Connectivity describes the contribution of patches of vegetation communities or habitat to the existence of corridors or vegetative links. This criterion is also related to the level of fragmentation (see below) in the landscape.

- **Fragmentation**

The level of fragmentation within a vegetation community or habitat type and within the landscape generally is of relevance in assessing the conservation value of patches of habitat or vegetation communities. Thus, areas which are essentially intact and have suffered little fragmentation are accorded higher conservation value than those which have been partly

disturbed and fragmented into smaller patches. Similarly, areas of vegetation communities which are a part of a substantial or intact area of vegetation are accorded higher conservation value than those which are located within highly fragmented landscapes. These considerations are the basis of the assignment of wilderness values to essentially large intact areas of vegetation.

- **Management**

The conservation value of areas of habitat or vegetation communities is also related both to their current management and to future management activities. On this basis, areas which are currently gazetted as Nature Reserves or National Parks are generally accorded higher conservation value than those on private land (although this is not necessarily the case). Additionally, the conservation value of a site may be related to proposals for future management for conservation purposes.

Biological Constraints

Portions of the study area or specific locations within it have been ranked from primary to quaternary constraint levels, based on their significance, conservation value, sensitivity and conservation status and on the presence of threatened species or significant ecological communities (Table 2.1).

It should be noted that the biological constraints defined and identified in this report are not intended to indicate areas of absolute prohibition, but to identify areas and sites which may involve relatively greater levels of environmental disturbance should roadworks proceed at these localities. More intensive or stringent impact amelioration measures are also likely to be required at these locations. Additionally, it must be noted that the constraint ratings of various sites and areas within the study area are relative values, and compare different portions of the study area to each other.

Primary constraints include localities, sites or species which should either be avoided altogether, on the basis of their very high conservation value, or which require extreme care to avoid the imposition of significant or notable effects. Biological features of the study area which are regarded as primary constraints include vegetation communities of restricted distribution, areas and sites containing a very high diversity and abundance of threatened plant species, and the populations of the Hairy Quandong (which is known from only five other locations in NSW) near Coolamon Scenic Drive. The Hairy Quandong is accorded primary constraint status because in addition to being an endangered species under the TSC Act, this species can not currently be propagated. Consequently, its conservation at any locality is dependant on the *in situ* retention of habitat and individuals. For other endangered plant species, as discussed in Chapter 6 of this report, moderate to high rates of propagation are achievable, providing a greater level of security. These other endangered plant species are consequently accorded secondary constraint status.

Secondary constraints include areas, sites or species which should be avoided, if possible. These are characterised by vegetation communities of moderate to high conservation value, often extensive in area and generally supporting a number of threatened plant species (*eg* subtropical rainforest). Given their good condition and size, it is likely that these vegetation communities support other threatened plants and are of particular relevance as habitat and/or support resources of relevance for threatened fauna. Included in areas considered of secondary constraint value are major fauna movement corridors, particularly those associated with Koalas, such as that along the central ridge of Coolamon Scenic Drive.

Tertiary constraints include areas supporting vegetation in good condition which is largely undisturbed, and riparian vegetation communities. Areas characterised as tertiary constraints generally do not support many threatened plant species, but do include vegetation communities which are not regarded as adequately conserved.

Quaternary constraints include vegetation communities which are dominated by regrowth or which have been significantly disturbed. Whilst in many instances these areas are regenerating and have significant future potential, they are currently in relative poor condition compared to other stands of vegetation in the study area. Although they doubtless have the potential to support threatened species, and if appropriately managed may

improve in their conservation value, they are of lower conservation value than the more substantial areas of native vegetation in better condition.

Areas which have been highly disturbed and modified, including agricultural land, existing when development and infrastructure sites, and other disturbed sites do not impose biological constraints on route options for the proposal.

Table 2.1 Criteria used to classify areas within the study area, into different constraint levels.

CONSTRAINT LEVEL	CRITERIA
Primary	The presence of the Hairy Quandong or A combination of the following: - high number of threatened* flora species present; and/or - largely undisturbed vegetation; and/or - Nature Reserve.
Secondary	A combination of the following: - largely undisturbed vegetation; and/or - 2 or more threatened* flora species present; and/or - fauna (Koala) movement corridors.
Tertiary	The presence of 1 threatened* flora species; and/or the presence of ROTAP species.
Quaternary	Vegetated areas of lower conservation concern (*ie* no known species of conservation concern; disturbed).

* Listed as threatened under the *NSW Threatened Species Conservation Act 1995*.

2.5 BIOLOGICAL CONSTRAINTS

2.5.1 Vegetation Communities

Of the vegetation communities identified in the study area, two areas of closed forest (rainforest) are regarded as primary constraints for the route selection. One area, located near Coolamon Scenic Drive in the central part of the original study area (Appendix 10), supports Unit 1c (sub-tropical rainforest), located along a creekline. This patch of rainforest, although relatively small, supports 4 threatened plant species (as listed on the TSC Act), and is in near pristine condition.

The second rainforest area of primary constraint value is rainforest on alluvium within the Brunswick Heads Nature Reserve, on the western side of the Pacific Highway. This area is considered to be of very high conservation value (J Hunter NP&WS *pers comm*), and is addressed in detail elsewhere in this report (Section 4).

Vegetation communities included as secondary constraints include those areas of rainforest communities which support a number of threatened plant species. Generally speaking, within the original study area, these stands of rainforest are of moderate size and are in relatively good condition, although examples in the western parts of the extended study area are smaller, and often more disturbed.

Areas of vegetation which provide potential fauna movement corridors within the study area and adjacent to it are located along the Brunswick River (along its banks), through the central part of the study area (north of Coolamon Scenic Drive), along Marshall's Creek near Billinudgel and in the north (south of Dirty Flat Road). These potential fauna movement corridors involve a range of vegetation communities and habitats, including:

- mangroves and swamp forests on the banks of the Brunswick River, which provide a potential movement corridor for wetland and littoral species;
- Blackbutt and Brush Box communities, along with patches of rainforest, in the central corridor of vegetation north of Coolamon Scenic Drive. This vegetation occurs along a ridge which is traversed by the existing highway, although the eastern side has largely been developed (Ocean Shores);

- riparian vegetation along Marshall's Creek. In this instance, there is substantial native vegetation east of the existing highway (including the Billinudgel Nature Reserve), but only limited vegetation to the west, because of clearing for agricultural purposes and development activities. Riparian vegetation along Marshall's Creek is generally limited and disturbed. It is of note, however, that occasional Koala road mortalities occur on the existing highway at this location (R Oehlman local resident *pers comm*); and
- a mosaic of vegetated land to the west of the existing highway south of the Dirty Flat Road, which also coincides with vegetated land to the east of the existing highway. This is another area where road mortalities occasionally occur (R Oehlman local resident *pers comm*).

Remaining areas of vegetation communities (including some rainforest patches, swamp-forest communities and areas of Blackbutt and Brush Box) which are in relatively good condition and are largely undisturbed have been included as tertiary constraints to the proposed upgrade (as defined above). In these instances, it is considered that whilst the vegetation communities are of some conservation value, a range of impact amelioration and site management protocols could be implemented to reduce the potential for adverse effects. Consequently, tertiary constraints do not represent features or resources which significantly affect the proposal. They do, however, constitute areas where impact amelioration measures and relevant design features are required.

Vegetation communities which are recovering from previous clearing or other disturbance, or which are in relatively poor condition, are classified as quaternary constraints. Whilst these areas may include or provide resources for some threatened species, and are capable of regeneration, they are of less conservation value in relative terms than those larger areas in better condition through the study area.

Another element in assessing potential constraints is the conservation ranking of the various vegetation communities, as discussed in Section 4 of this report. In this regard, the rainforests within the study area are generally ranked as "*adequately conserved*" (Floyd 1990), whilst the Blackbutt, Brush Box and Swamp Sclerophyll Forest are "*inadequately conserved*" (Hager & Benson 1992). The conservation status of these communities is of some relevance in the ranking of biological constraints in this investigation, particularly with respect to the potential for disturbing significant stands of these communities (*eg* along the Brunswick River, near the Brunswick Sewage Treatment Plant and along the central east-west ridge). Nevertheless, the highest priority has been accorded to flora species listed as Endangered or Vulnerable on the TSC Act.

A large portion of the Blackbutt and Brush Box community types (regarded as "*inadequately conserved*") are already regarded as secondary constraints, on the basis that they constitute a fauna (Koala) movement corridor (see above).

Many areas of Swamp Sclerophyll Forest within the study area are described as having "*some disturbance*" or as being "*partially cleared and/or regenerating*". These patches, although not the best representatives of Swamp Sclerophyll Forest, are of some conservation significance. Areas of particular significance are located near the Brunswick Heads Nature Reserve and along the Brunswick River. There is a small area of Swamp Sclerophyll Forest located just south of Billinudgel, which is described as "*largely undisturbed and in good condition*". Although this area is small, its protection is pertinent as any reduction in its size could reduce its viability.

2.5.2 Threatened Plant Species

Whilst there are a number of threatened plant species (as listed on the TSC Act) known from the study area and general vicinity, only one (the Hairy Quandong *Elaeocarpus williamsianus*) has been listed specifically as a primary constraint.

The Hairy Quandong has been identified in the study area, in the vicinity of one of the potential route options (Figure 9). This species is known from only six recorded locations in NSW, and is consequently accorded a very high conservation value by the NSW NP&WS, and primary constraint status for this investigation. Because this plant is an extremely poor candidate for propagation and cultivation (NP&WS; A Benwell *pers comm;* Appendix 8), it is deemed necessary to protect the existing stand *in situ*.

The other threatened flora species known from the vicinity, conversely, occur more widely through the landscape (with the exception of the Queensland Nut, which is present only as a single individual and will not be affected by any of the route options). As a consequence, none of these species would be removed entirely from the locality as a consequence of any individual route option. Furthermore, these other species are readily propagated, and their conservation therefore does not require the *in situ* retention of any individual plants.

Elsewhere in the study area, vegetation communities which support a number of threatened plant species are regarded as secondary constraints. In essence, all threatened plant species are of high conservation value, and the proposed final alignment must attempt to minimise adverse impacts upon threatened species in general.

Conversely, the ability to propagate different threatened plant species varies significantly. Consequently, whilst the final alignment may involve the removal or disturbance of some individuals of threatened plant species, it is relevant to take into consideration the potential of species to be readily propagated. Appendix 8 provides a description of the likely success of propagating the significant flora species known from the study area.

2.5.3 Threatened Fauna Species

Because of the mobility of most threatened fauna species, it has not been possible to identify areas of primary constraint on the basis of the presence of individual animals. The imposition of constraint values with respect to native fauna is related substantially to the vegetation communities and to specific habitat resources present in individual areas.

The threatened fauna species regarded as of particular relevance as a biological constraint is the Koala. Direct sightings and indirect evidence (Koala roadkills and scratches on trees) indicate that Koalas are present at scattered locations through the landscape, and use the Blackbutt and Brush Box communities in the central portion of the study area. These communities occupy a range of hills which traverse the study area in an east-west direction, and intersect with the existing highway. On the basis that it appears certain that Koalas utilise this area for movement through the landscape, this area has been designated a secondary constraint with respect to the location of the proposed upgrade.

Koala mortalities have also been recorded along the existing highway at the northern end of the propose upgrade, south of Dirty Flat Road. In this locality stands of swamp forest occur to the east of the existing highway, including within the Billinudgel Nature Reserve. To the west of the highway, a range of sparsely wooded hills provides a potential connection to more extensive woodland and forest communities to the west and northwest.

Whilst other threatened fauna are addressed in this study, it is essentially not possible to identify restricted or particular constraint sites for the proposed upgrade for most threatened fauna species. The approach to be adopted with regard to the proposed upgrade will include minimisation of adverse impacts (such as vegetation clearing and contaminant discharge), careful management of erosion and exposed soils (to avoid sediment discharge into wetland habitats), and the provision of fauna movement features (such as tunnels or bridges) to ameliorate adverse impacts upon threatened fauna species. These measures, and the provision of compensatory or replacement habitat and resources, limit the potential for the proposed upgrade to significantly affect threatened fauna species.

2.6 OTHER CONSTRAINTS

2.6.1 SEPP 14 Coastal Wetlands

State Environmental Planning Policy No 14 - Coastal Wetlands (SEPP 14) was gazetted with the "*aim to ensure that coastal wetlands are preserved and protected in the environmental and economic interests of the State*". This policy does not indicate that no developments are permitted on lands designated as SEPP 14, but that:

> "*developments are permitted provided there are no feasible alternatives, they are located and designed with care, and do not significantly reduce the value of the wetland. Additional works to preserve or enhance a nearby wetland are also taken into consideration*" (Smith 1993).

The consent authority for SEPP 14 in this locality is Byron Shire Council, and consent to disturb the wetlands will also require the concurrence of the Director-General of DUAP.

There are several SEPP 14 Coastal Wetlands located within the extended study area (Figure 5) including;

- SEPP 14 Coastal Wetland No 62, which is located in an east-west direction, on the northern side of the Brunswick River. Coastal Wetland No 62 is likely to be affected to some degree by Options A to E, due to its location and extent;
- SEPP 14 Coastal Wetland No 65 occupies the southern bank of the Brunswick River, east of the existing highway. Some route options for the upgrade would affect this wetland, although the areas to be disturbed are already affected by human activities, and are extremely limited; and
- SEPP 14 Coastal Wetland No 57 is located to the east of the existing highway in the north of the study area, overlapping part of the Billinudgel Nature Reserve. Coastal Wetland No 57 could readily be avoided by all options.

One additional wetland (SEPP 14 Coastal Wetland No 64) is located on an island in the Brunswick River, west of the existing highway. This wetland is not likely to be directly affected by the proposed upgrade. SEPP 14 Wetlands Nos 66, 66a, 66b, 66c and 71 occur along the Brunswick River or on its floodplain to the west of the existing Brunswick Heads Bypass. None of these wetlands will be affected by any of the route options.

2.6.2 Nature Reserves

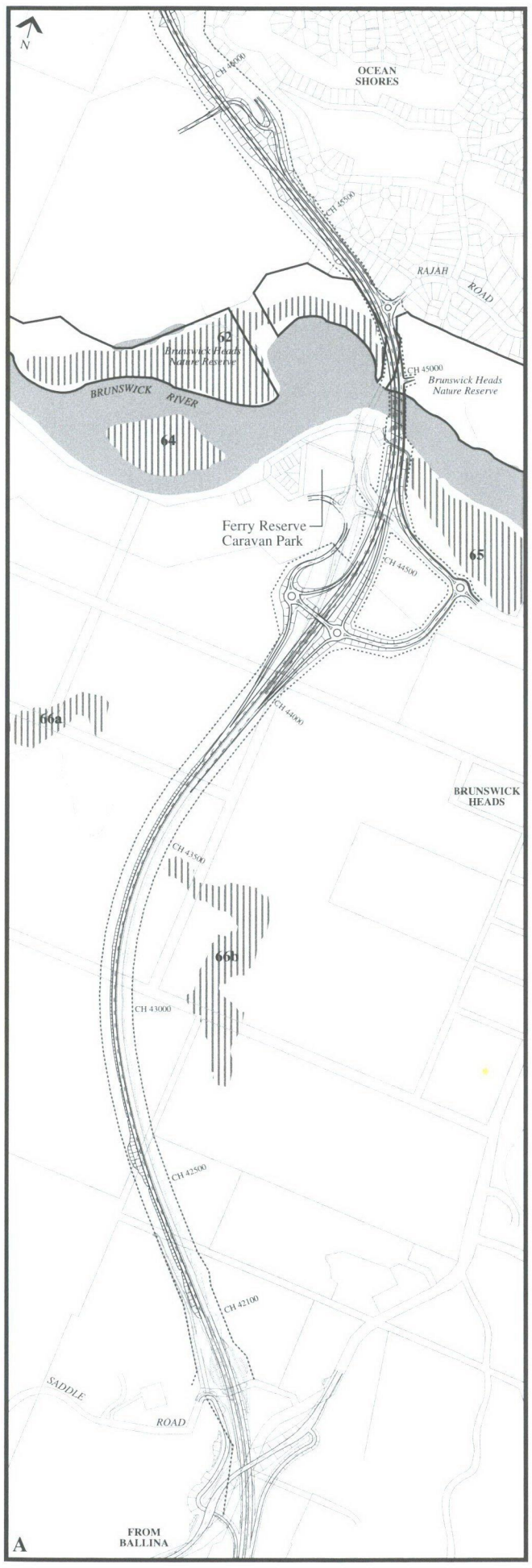
The Brunswick Heads Nature Reserve and the Billinudgel Nature Reserve are located partially in the study area (Figure 5). Dedication of lands as Nature Reserves indicates a high level of conservation value, and these lands consequently are regarded as primary constraints for the proposed upgrade.

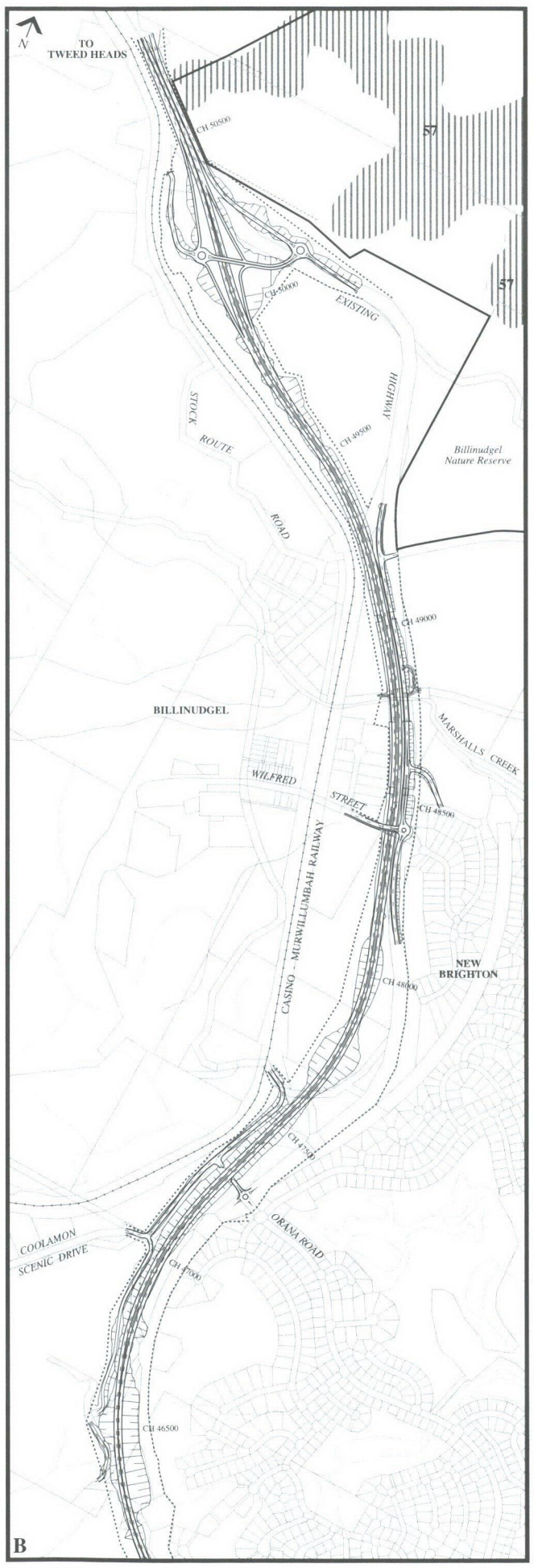
Impacts upon Nature Reserves should be avoided if at all possible. Conversely, limited additional disturbance to the edges of Nature Reserves could be considered acceptable when weighed against other biological factors. The creation of a new or additional disturbance corridor through a Nature Reserve is considered an unacceptable impact, at least from a conservation perspective. Brunswick Heads Nature Reserve is located across the entire original study area in an east-west direction, on the northern side of the Brunswick River. This Nature Reserve also extends eastwards to the coast, and includes coastal areas south to the northern headland of Brunswick Heads and north for approximately 1.75km.

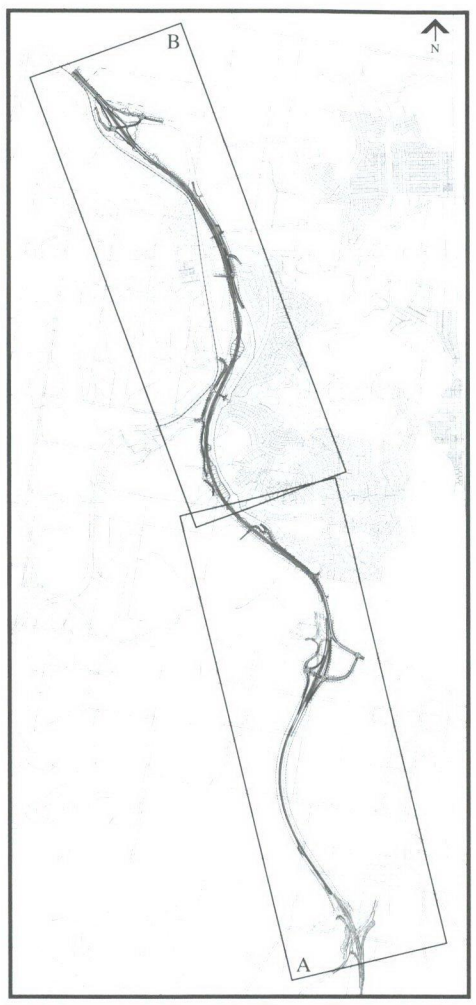
Brunswick Heads Nature Reserve will be affected to a limited extent by the easternmost options (A and B) for the proposed Pacific Highway upgrade. In addition to the direct removal of vegetation and habitats, indirect effects from the roadway on the Nature Reserve may arise as a result of alterations in stormwater discharge, potential contaminant discharge (particularly road runoff), alterations in light and shade regimes, and possible increases in weed infestation. Conversely, route options C, D and E involve the provision of an additional corridor of disturbance, habitat loss and wildlife mortality through the Nature Reserve.

Billinudgel Nature Reserve is located to the east of the existing highway, at the northern end of the study area. This Nature Reserve extends approximately 3km east to the coastline, where it extends northward from New Brighton to about 1km south of Wooyung. Only a very small area of the Billinudgel Nature Reserve is actually located within the original study area, and this can readily be avoided.

Depending on the location of the proposed highway and the implementation of engineering protocols in the project, it is probable that a portion of the Brunswick Heads Nature Reserve would be directly affected by the proposed Pacific Highway upgrade. For some route options (A and B), it is likely that a small portion of the Nature Reserve would need to be excised, in order to permit roadworks to occur within it. In this instance, it would be necessary to arrange for the revocation of part of the Nature Reserve, involving an act of the NSW Parliament, as required under Section 52(1) of the *National Parks & Wildlife Act 1974* (NP&W Act). Further consideration of the Brunswick Heads Nature Reserve is included in Sections 6 and 7 of this report.







Legend

- Nature Reserve
- SEPP 14 Coastal Wetlands
- Proposed Road Corridor

0 100 500m

Figure 5
LOCATIONS OF AREAS OF CONSERVATION SIGNIFICANCE (SEPP 14 WETLANDS, BRUNSWICK HEADS NATURE RESERVE AND BILLINUDGEL NATURE RESERVE)

Figure 5
LOCATIONS OF AREAS OF CONSERVATION SIGNIFICANCE (SEPP 14 WETLANDS, BRUNSWICK HEADS NATURE RESERVE AND BILLINUDGEL NATURE RESERVE)

2.7 CONSERVATION VALUES - GEOGRAPHICAL CONTEXT

The conservation values of the area and the likely impacts to be imposed can be addressed in terms of national, state, regional and local conservation significance, and on the basis of general biodiversity, threatened species and vegetation communities.

In broad terms, the area which will be affected by the proposed upgrade (essentially regardless of the route selected) is clearly of local conservation significance, given the number of threatened species and the condition and nature of the ecological communities present. Conversely, the area generally is already moderately to highly disturbed by the existing highway, residential development, other urban infrastructure and clearing for agricultural and other activities, and is only of relatively small size (on a regional or state-wide basis). Nevertheless, the study area generally and each of the route options individually is of moderate conservation significance in local terms, with the route options having different values (as noted below).

There are a considerable number of threatened fauna and flora species known or likely to be present in the study area, and there are moderately large tracts of vegetation which are either of relatively high conservation value in their own right or which support threatened species. Consequently, the potential for disturbance of threatened and significant fauna and flora is moderately high, although the area has been long subjected to disturbance from the existing highway, urban development, clearing, agriculture and other activities.

In regional terms, the study area is located within the NSW North Coast bioregion, as listed in the Interim Biogeographic Regionalisation of Australia - IBRA (Thackway & Cresswell 1995). This region extends from Port Stephens to the Queensland border, and inland to the western side of the Dividing Range. On a regional basis, the features and areas of significance for fauna and flora are relatively small. Conversely, there are a number of threatened species of particular value, and the area generally supports a relatively high density and diversity of threatened fauna and flora.

In state terms, there are seven endangered and eight vulnerable plant species (as listed on the TSC Act), and potentially a total of twenty-six additional threatened plant species. Fifty-two threatened fauna species have been recorded in the region, and many could potentially occur at least on occasions in the study area, given the presence of suitable habitat. Eight threatened species have been recorded in the study area, and an additional sixteen threatened fauna species are considered likely to be present. On this basis, the study area is of some state conservation significance, with some particular elements (*eg* the Hairy Quandong) being of special conservation value.

There are six Endangered and seven Vulnerable plant species at the national level (as listed on the Commonwealth ESP Act) present in the extended study area, and potentially an additional twenty-two such plant species. On this basis, the study area may be argued as having some conservation status in national terms, although this would be low compared to areas with more intact native vegetation.

2.8 CHARACTERISTICS of ROUTE OPTIONS

Seven potential route options have been identified, with several of the options (A, B, F and G) including alternatives. Each of the potential route options were assessed with respect to the constraints discussed above, as part of the process of determining the preferred route option (Table 2.2).

It is of particular relevance to note that, by virtue of the nature of the study area and on the basis of the local distribution of threatened fauna and flora species and the habitats and vegetation communities on which they depend, it is essentially not possible to avoid imposing some adverse effects on significant elements of the natural environment, irrespective of the route selected. In some instances, a route may involve significant potential effects on a specific threatened species or its habitat. In others, more general effects arising from disturbance to intact vegetation communities ('edge-effects' or fragmentation) and the imposition of new impacts and barriers in areas otherwise currently unaffected may be imposed.

The approach adopted in the selection of a preferred route involved minimisation of the intensity and extent of the adverse impacts which would be imposed, and also having regard to compensation for those impacts which are likely to occur.

2.9 PREFERRED ROUTE

A Value Management Workshop (VMW) was conducted with representatives of relevant stakeholders, to determine which of the potential routes was considered the most appropriate for the proposed upgrade. In addition to the dedicated assessment of the route options in the two-day VMW, an extended period of public display and consultation was conducted to obtain input into the route selection process from the community and other interested parties.

Following the public consultation period, and review of the various route options available with regard to biological constraints (as documented above), route option A was selected as the preferred route. For both the A and B options, two alternative bridge structures across the Brunswick River had been proposed, involving a low level bridge constructed at approximately the same height above water as the existing bridge over the River (options A2 and B2), and a high level bridge with an elevated roadway on the northern side of the Brunswick River (options A1 and B1).

Classification of Route Options

The five original route options (Routes A-E) with the two high level bridge over the Brunswick River options (Options A1 and B1) and subsequently the two western options (Routes F and G) were considered with respect to the evaluation criteria discussed above. Routes A to F were considered at the Value Management Workshop, and an assessment made as to the likely impacts of each route option with respect to threatened species, habitat fragmentation, habitat and vegetation severance, and the area of vegetation communities to be cleared (Table 2.3). These issues were considered by the principle author (F Dominic Fanning) and Mr J Hunter of the NP&WS (Northern Zone Team, Coffs Harbour), and presented to the Value Management Workshop in April 1997.

Consideration of the relative contribution of the route options to the potential imposition of impacts on the natural environment under these categories (Table 2.3), as evaluated at the Value Management Workshop, indicates the lower intensity of adverse impacts imposed by route options A and B, compared to those which would be imposed by route options E, F or G.

Other evaluation criteria which were applied to the various route options as part of the Value Management Workshop (involving representative stakeholders from all elements of the community and relevant organisations) included:

- social impact (15%);
- visual impact (1%);
- noise impact (4%);
- transport efficiency (14%);
- land use planning (24%); and
- commercial impact (13%).

Of these criteria, the ecological impacts were recorded the greatest weighting or ranking (29% of the criteria weighting) by all involved at the VMW, followed by land use planning (24%). Social impact, transport efficiency and commercial impact were accorded an intermediate level of weighting, and the visual and noise impacts were accorded low levels of significance by the VMW participants.

As with the ranking based solely on ecological criteria (Table 2.3), evaluation of the various route options using the full matrix of evaluation criteria against the various options (A-G) again resulted in route option A2 being accorded the highest ranking (by a significant margin). Thus, both on ecological criteria alone and on the broad suite of social, physical and biological criteria, the preferred option for the upgrade of the Pacific Highway at Brunswick Heads is Route A2.

Table 2.2 Comments on route options for the proposed upgrade of the Pacific Highway between Brunswick Heads and Yelgun.

ROUTE A	ROUTE B	ROUTE C	ROUTE D
• Designed to avoid affecting the saltmarsh at southern nterchange (south of Brunswick River); • disturbed rainforest edge and car park east of existing bridge at the edge of Brunswick Heads Nature Reserve (on north side of Brunswick River) - adverse effects are limited because of existing disturbance, can be managed; • minor disturbance to significant alluvial rainforest west of the existing highway (in Brunswick Heads NR), involving approximately 0.1ha of already disturbed vegetation; • minimises the potential for effects on Brunswick Heads Nature Reserve by not clearing vegetation in the existing LEP corridor; • generally avoids fragmentation of vegetation communities along the route, thus avoiding the creation of non-viable vegetation remants; • likely to affect threatened flora species at some localities (especially in the Smokey Valley area), but has been designed to minimise adverse impacts; • affects edges of forest remnants in some places, although these are already disturbed; • no currently undisturbed or intact vegetation will require removal; • avoids the imposition of additional barriers to fauna movement through the landscape; • most of route is located in disturbed or modified agricultural or urban land, and/or has been subjected to modification (including previous clearing) and 'edge-effects'.	• Designed to avoid affecting the saltmarsh at southern interchange (south of Brunswick River); • disturbed rainforest edge and car park east of existing bridge at the edge of Brunswick Heads Nature Reserve (on north side of Brunswick River) - adverse effects are limited because of existing disturbance, can be managed; minor disturbance to significant alluvial rainforest west of the existing highway (in Brunswick Heads NR), involving approximately 0.1ha of already disturbed vegetation; • minimises the potential for effects on Brunswick Heads Nature Reserve by not clearing vegetation in the existing LEP corridor; • south of Coolamon Scenic Drive, route affects edges of forest remnants (which are already disturbed); • deviation north of Coolamon Scenic Drive through disturbed area, but adjacent to high value rainforest with high densities of threatened flora; • likely to affect threatened flora species at some localities (Smokey Valley, Coolamon Scenic Drive); • provides an additional barrier to the central wildlife corridor; • remainder of route (from north of Coolamon Scenic Drive to Yelgun) is primarily through cleared agricultural land.	• Avoids saltmarsh at southern interchange; • utilises existing LEP reserve in Brunswick Heads Nature Reserve; • vegetation in LEP reserve is of ecological value, and is identical in type, condition and conservation value to that on either side (in the Nature Reserve); • increases fragmentation and 'edge-effect' of vegetation between Brunswick River and Coolamon Scenic Drive (including Brunswick Heads Nature Reserve); • bisects moderate-sized areas of native forest south of Coolamon Scenic Drive; • significant increases in fragmentation and reductions in naturalness, connectivity and viability of vegetation patches; • significant increase in 'edge-effect' of remnant patches south of Billinudgel; • deviation north of Coolamon Scenic Drive through disturbed area, but adjacent to high value rainforest; • imposes an additional significant barrier to fauna movements through the landscape; • likely to affect threatened flora species; • affects edges of forest remnants in some places, although these are already disturbed.	• Avoids saltmarsh at southern interchange; • utilises existing LEP reserve in Brunswick Heads Nature Reserve; • vegetation in LEP reserve is of ecological value, and is identical in type, condition and conservation value to that on either side (in the Nature Reserve); • increases fragmentation and 'edge-effect' of vegetation between Brunswick River and Coolamon Scenic Drive (including Brunswick Heads Nature Reserve); • bisects moderate-sized areas of native forest south of Coolamon Scenic Drive; • significant increases in fragmentation and reductions in naturalness, connectivity and viability of vegetation patches; • significant increase in 'edge-effect' of remnant patches; • imposes an additional significant barrier to fauna movements through the landscape; • likely to affect threatened flora species; • remainder of route (from north of Coolamon Scenic Drive to Yelgun) is primarily through cleared agricultural land.

Table 2.2 contd Comments on route options for the proposed upgrade of the Pacific Highway between Brunswick Heads and Yelgun.

ROUTE E	ROUTE F	ROUTE G
• Avoids saltmarsh at southern interchange; • may utilise existing LEP reserve in Brunswick Heads Nature Reserve, or else affects the Nature Reserve directly; • vegetation in LEP reserve is identical in type, condition and conservation value to that on either side; • substantial clearing required to the north of the Brunswick River; • increased fragmentation through Brunswick Heads Nature Reserve; • significant increases in fragmentation and reductions in naturalness, connectivity and viability of vegetation patches; • provides additional significant barrier to wildlife movements across central wildlife corridor; • considerable increase in edge-effects, vegetation and habitat loss; • will affect threatened flora species in stands of native and regrowth vegetation.	• Avoids potential effects on Brunswick Heads Nature Reserve; • avoids potential effects on the saltmarsh to the south of the Brunswick River; • will affect threatened flora species, particularly west of the Brunswick River and in the Hilans Corner areas; • significantly increases fragmentation and 'edge-effect' on remnant vegetation patches to the west of the Brunswick River and at Hilans Corner; • bisects moderate-sized areas of natural vegetation to the west of Brunswick River (south of Coolamon Scenic Drive) which are currently little disturbed; • significant educations in naturalness, connectivity and viability of vegetation patches; • introduces additional major barrier to fauna with regard to east-west movement along the central ridge, and north-south through vegetation along and near to Brunswick River.	• Avoids potential effects on Brunswick Heads Nature Reserve; • avoids potential effects on the saltmarsh to the south of Brunswick River; • will affect threatened flora species, particularly west of the Brunswick River and in the Hilans Corner areas; • significantly increases fragmentation and 'edge-effect' on remnant vegetation patches to the west of the Brunswick River and at Hilans Corner; • bisects moderate-sized areas of natural vegetation to the west of Brunswick River (south of Coolamon Scenic Drive) and at Hilans Corner which are currently little disturbed; • significant educations in naturalness, connectivity and viability of vegetation patches; • introduces additional major barrier to fauna with regard to east-west movement along the central ridge, and north-south through vegetation along and near to Brunswick River.

Table 2.3 Evaluation criteria and rankings for biological features of the route options considered for the proposal (at the 1997 Value Management Workshop).

ROUTES	A1	A2	B1	B2	C	D	E	F*	G*
THREATENED SPECIES Fauna and Flora	2	2	3	3	1	2	2	3	3
HABITAT FRAGMENTATION Creation of Small Fragments	1.5	1.5	2	2	3	3.5	2	2	2
HABITAT SEVERANCE Corridors	1	1	1.5	1.5	3	3	4	3	3
AREA CLEARED Native Vegetation	1	1.5	2	2.5	3	3	4	3	3
TOTAL	**5.5**	**6**	**8.5**	**9**	**10**	**11.5**	**12**	**11**	**11**

* Assumed Best Route Option (*ie* least impact)

RANKINGS			
0	None	3	High
1	Low	4	Very High
2	Moderate	5	Extreme

Route A2 was subsequently announced as the preferred route for the proposed upgrade. Route A2 involves closely paralleling the existing highway, and is located along the eastern side of the study area, to the west of Ocean Shores (Figure 2).

Route A2, as described in detail in the EIS, was selected as the preferred route for a number of reasons. It is clear that any alignment for a new highway through this part of north coastal NSW will inevitably involve some disturbance to habitats and resources of relevance for threatened fauna species, and has the potential to involve the imposition of effects on threatened plant species, including the loss of some individuals. Consequently, it is necessary to adopt an approach which concentrates on minimising the imposition of adverse effects on the natural environment and on threatened biota. Whilst the Route A2 option will affect some individual threatened plant species and is likely to involve limited effects on some threatened fauna, similar considerations would apply to any other option selected.

The A2 option has been selected as the preferred alignment for the Brunswick Heads to Yelgun upgrade of the Pacific Highway, in consultation with relevant authorities and with the general community, amongst other considerations on the basis that:

- most of the areas to be affected by Route A2 are already somewhat disturbed or highly modified from their original condition. This option is located in areas of vegetation which have been affected by the existing highway, by clearing and agricultural practices, and by previous development or disturbance;
- disturbance to existing relatively intact native vegetation in the locality is largely avoided. Other options would have involved the imposition of multiple disturbance and clearing activities into areas which are currently in good to excellent condition. The western options would require the removal of substantially larger areas of native vegetation;
- the fragmentation of habitats and vegetation communities is minimised by locating the upgrade as close as possible to the existing highway and areas of current disturbance. Other options for the alignment would have involved the fragmentation of existing large tracts of vegetation (particularly to the west and north of the Brunswick River), and the creation of less viable habitats and fauna and flora communities;

- location of the new alignment in the immediate vicinity of the existing highway avoids the imposition of a second major barrier to fauna movements in an east/west direction through the landscape. The selection of route options to the west would require the severance of existing fauna movement corridors, and impose a significantly greater effect upon native fauna than Route A2;
- additional potential 'black spots' for fauna mortalities along the highway will be minimised because habitat fragmentation and the imposition of a second barrier to fauna movement through the landscape has been avoided by selection of Route A2; and
- the upgrade along Route A2 is located at the boundary between development (to the east) and areas of agricultural activities and native vegetation (to the west). Thus, Route A2 does not significantly extend the area of disturbed lands west of that area which is currently affected.

The remainder of this fauna and flora report addresses the vegetation communities, habitats and biota which occur along Route A2 and in its immediate vicinity, and describes the nature of the existing environment. Details of threatened fauna and flora species of relevance are included, as is an assessment of the impacts which are likely to or which may be imposed as a result of the proposal. The report also outlines impact amelioration and environmental management measures to be applied as part of the proposal.

3 METHODS

3.1 FLORA

3.1.1 Brunswick Heads Bypass Duplication

Botanical surveys of the area along the Bypass, comprising the western half of the existing fenced Bypass corridor and an additional 50 metres westward, were conducted on one day in December 1996 and over three days in July 1997. The investigation included a one-day preliminary investigation and a detailed two-day survey of the area, to supplement the original investigations in the locality conducted by Landmark Ecological Services (LES 1994). The field investigations largely conformed to the 'random meander survey technique' (Cropper 1993), which is recommended by the NP&WS for targetting rare or threatened plant species, although representative survey plots were documented in each vegetation community (Appendix 1).

All plant species encountered during field surveys were identified and recorded (Appendix 3a), with unidentified species being sent to the Royal Botanic Gardens Herbarium in Sydney for identification.

Plant species nomenclature conforms to the *Flora of NSW* (Harden 1990-3) and to recent changes in *Cunninghamia* and *Telopea*. Detailed searches were undertaken for rare, threatened or regionally significant plants within areas of potential habitat, with remnant groups of rainforest trees, paperbark forest with a rainforest understorey and less disturbed areas of open forest being particularly targeted.

Specific searches for several rare orchid species had previously been conducted in the study area (LES 1994), as a response to concerns raised by the NP&WS. The LES (1994) report provided a number of conclusions and recommendations with respect to the ground orchids, which were taken into consideration when determining the search methods for the current study, including the statement that:

> *"it is not possible to be completely certain that particular rare species of terrestrial orchids are not present at the site. Many terrestrial orchids flower irregularly and may remain dormant and leafless for long periods. Surveys at different seasons, repeated for a number of years, would be necessary for a high degree of certainty that the species are not present. Such survey effort cannot be reasonably expected unless the presence of rare species has been strongly suggested".*

LES (1994) suggested that the orchid species of conservation significance (*Caladenia alata, C rosella, C tessellata, Cryptostylis hunteriana* and *Dendrobium schneiderae*) were unlikely to occur in vegetation which would be affected by the original proposed Brunswick Bypass. The conclusion of Milledge (LES 1994) is even more applicable to the area of the proposed Bypass duplication, given the high levels of disturbance which have already occurred.

The conservation significance of plants recorded in the study has been assessed with reference to:

- Parts 1 (Endangered) and 2 (Vulnerable) of the ESP Act for plants of national conservation significance;
- Schedules 1 (Endangered) and 2 (Vulnerable) of the TSC Act for plants of state conservation significance;
- Briggs & Leigh (1996) for Rare Or Threatened Australian Plants (ROTAP); and
- DeVries (1997 draft) and Sheringham & Westaway (1995) for regionally significant plants.

A vegetation map of the study area was produced as a result of aerial photo interpretation (API), ground-truthing of API boundaries and a systematic vegetation survey, following the methods set out by the NP&WS (1995). The vegetation map is based on 1:8000 colour aerial photos taken in January 1997, after the start of construction of the first carriageway of the Bypass.

Vegetation communities were classified firstly as broad ecological vegetation types, and then as plant associations[6]. The vegetation classification map of Milledge & McKinley (1992) was also used as a guide to vegetation types and boundaries.

Vegetation floristics and structure were recorded at representative sites within each plant community, although fixed and standardised quadrats were not utilised. At each of the survey sites, the main species in the upper, middle and lower strata were recorded, and structural attributes were obtained according to Walker & Hopkins (1990).

3.1.2 Brunswick to Yelgun Upgrade

The flora study area for the section of the proposal from Brunswick to Yelgun involved land on and adjacent to the proposed road corridor, including adjacent lands to the east and a band several hundred metres wide on the western side. The proposal is generally within 100 metres and to the west of the existing highway alignment, apart from a section at the northern end where the deviation from the existing alignment is up to 200 metres (Figure 1) and in the vicinity of the Brunswick River, where the alignment is to the east of the existing highway.

Initial flora surveys for the route selection study were conducted in December 1996 and in January and April 1997 (Appendix 1). Further surveys were conducted in July, November and December 1997 to complete the detailed surveys along the proposed route. A total of eleven days were dedicated to the detailed flora field survey work (Appendix 1).

During field surveys, all plant species encountered were identified and recorded (Appendix 3b), and intensive searches were conducted in potential habitats for rare, threatened and regionally significant plants. Plant species nomenclature throughout this report (Appendix 3b) conforms to the *Flora of NSW* (Harden 1990-3) and recent name changes in *Telopea* and *Cunninghamia*.

Two approaches to field investigations were applied, as required to fulfil the various requests and information needs at different stages of the project development. A considerable number of brief but detailed surveys were required during the route selection process, to identify vegetation communities present and the likelihood of threatened flora species occurring at localities along the potential routes. These rapid (though detailed) investigations conform most closely to the 'random meander technique' of Cropper (1993), which is a flora survey technique recommended by the NP&WS for rare or threatened flora species.

The survey methods for flora which have been applied along the Brunswick to Yelgun upgrade of the Pacific Highway (Appendix 1) include:

- the 'random meander technique' (Cropper 1993), applied widely throughout the study area, including the whole of the route selection options study area (Figures 3 and 4), to provide general information regarding vegetation communities and the occurrence of threatened plant species;
- detailed and accurate location of individual threatened plant species, and the surveying of those locations, to assist in the final design and engineering requirements for the upgrade. This technique was particularly relevant in the vicinity of the Brunswick Heads Nature Reserve, in the southern portions of the upgrade alignment; and
- the collection of data from survey plots within representative samples of the various vegetation communities present, obtaining detailed information on structure and floristics at each of the sites (Appendix 1).

Vegetation was mapped by aerial photograph interpretation (API), ground-truthing, and systematic surveys employing the methods noted above. Plant community boundaries were obtained from large scale (1:5435) colour aerial photography. Vegetation communities were classified firstly as broad ecological vegetation types and then as plant associations. During ground-truthing activities, vegetation floristics and structure were recorded at sites representative of each 'association'. At each survey site, the main species present in the

[6] An "*association*" is a plant species assemblage or community with consistent structure and dominant species in the upper stratum (Beadle 1981).

upper, mid and lower strata were recorded and structural attributes were recorded according to Walker & Hopkins (1990).

The condition or intactness of plant communities throughout the study area was assessed on the basis of a relative, qualitative scale, which considers the following criteria for each association:

- spatial extent;
- structural maturity;
- plant species diversity;
- weed infestation; and
- impacts of previous or existing disturbance.

The conservation status of plant communities was assessed according to Hager & Benson (1994). This is the most comprehensive current study of the conservation status of plant communities in northeast NSW. In using tables from Hager & Benson (1994), associations were converted to forest types (FCNSW 1989), which are broader vegetation communities usually encompassing several associations. The conservation status of vegetation communities was also assessed by reference to Griffith (1993), and that of rainforest vegetation types according to the suballiances in Floyd (1990) and in Griffith (1993).

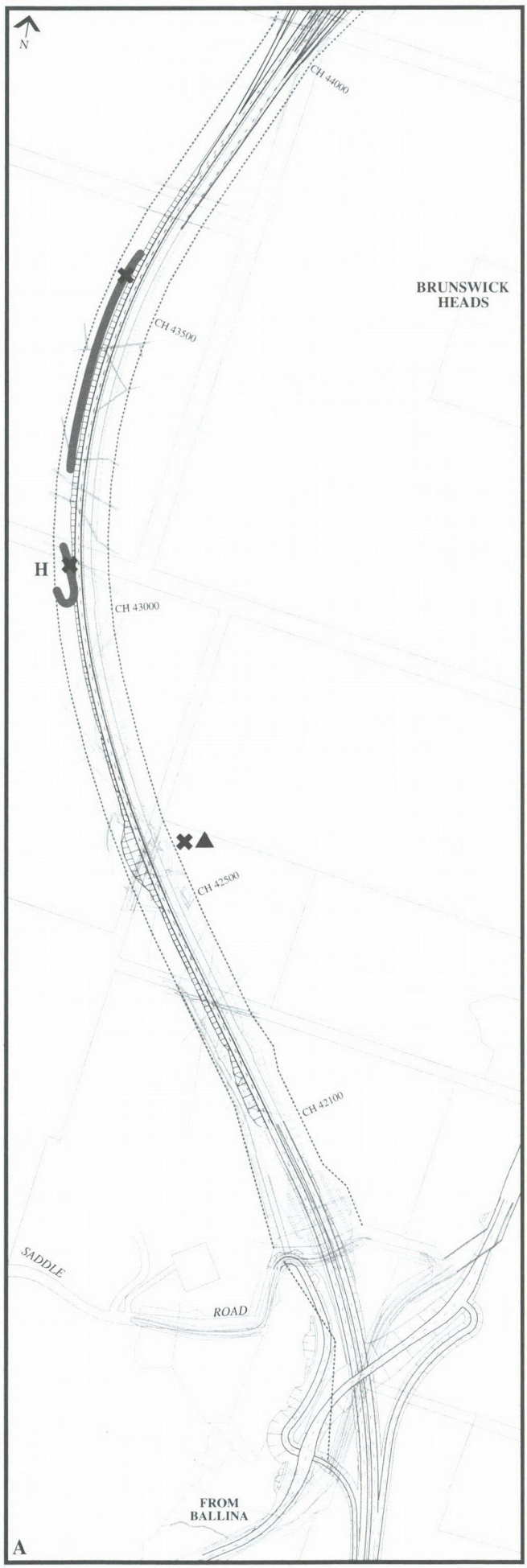
3.2 FAUNA

3.2.1 Brunswick Heads Bypass Duplication

A preliminary site inspection of the land to the west of the Brunswick Heads Bypass construction was conducted in December 1996. This provided initial information on the general condition of the land, and determined the level of detailed field work that was required. Preliminary observations of habitat and fauna were noted and are incorporated into this report.

Detailed field surveys were conducted along the proposed Bypass duplication alignment between the 18th and the 22nd of November, 1997 and involved:

- the placement of one split trapline (Figure 6) in areas that supported the least disturbed habitat along the Bypass. The trapline was set over four nights (the 18th to 21st of November 1997, inclusive) and included 25 Elliott traps, 18 of which were placed on the ground and 7 of which were tree-mounted, yielding a total of 100 Elliott trap-nights. Three cage traps were also set along the trap-line for a total of 12 cage trap-nights;
- Elliott traps were set with a standard bait mix (peanut butter, honey and rolled oats mixture), and cage traps were set with both vegetarian and meat (chicken parts) baits;
- the placement of one split hair-tube line along the trapline discussed above (Figure 6). A total of 14 hair-tubes were set with vegetarian and meat baits for 13 nights (a total of 182 hair-tube nights). The hairs collected were sent to Mr AB Rose and Ms M Bowen for identification;
- the setting of Anabat II detectors, for approximately 2 hours each at three separate locations along the Bypass (on noise-activation mode), on the 19th of November 1997, providing a total of 6 Anabat-hours of survey;
- 4.25 person-hours spotlighting along the Bypass on the 19th of November 1997, and a further 2 person-hours spotlighting in the same area on the 21st of November;
- diurnal bird, reptile and amphibian surveys conducted opportunistically throughout the five days of surveys in the study area. Amphibians were mainly detected at night through call identification, but also through direct observation;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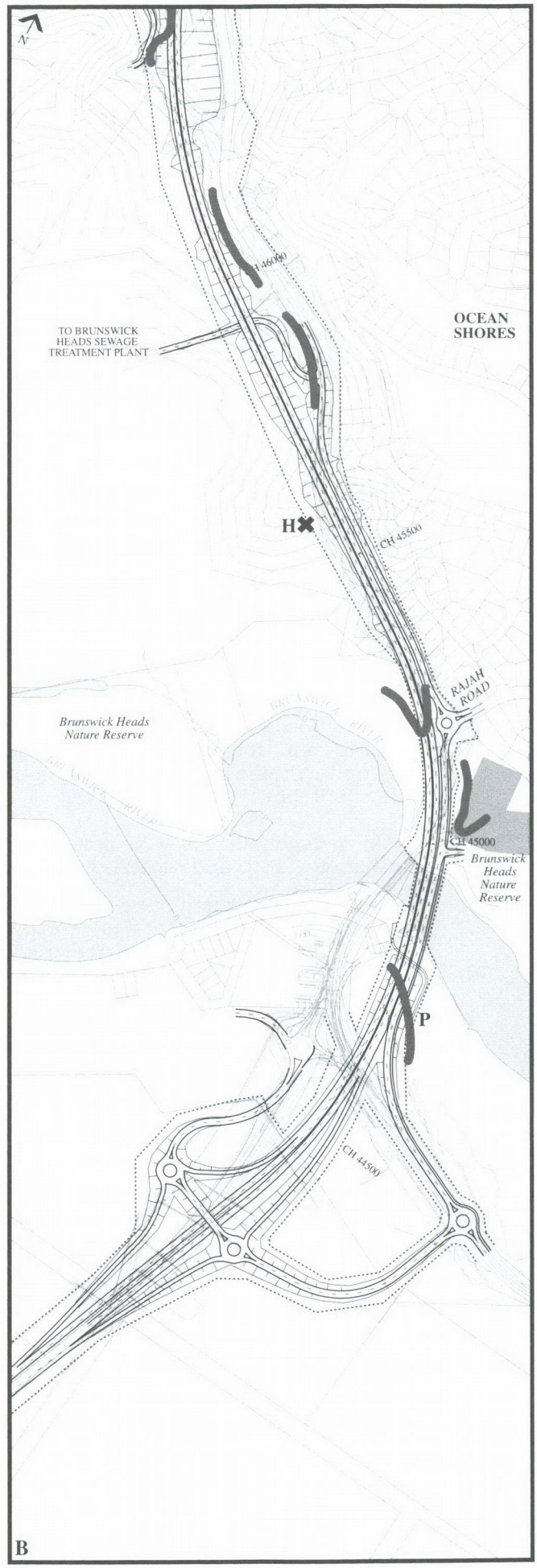
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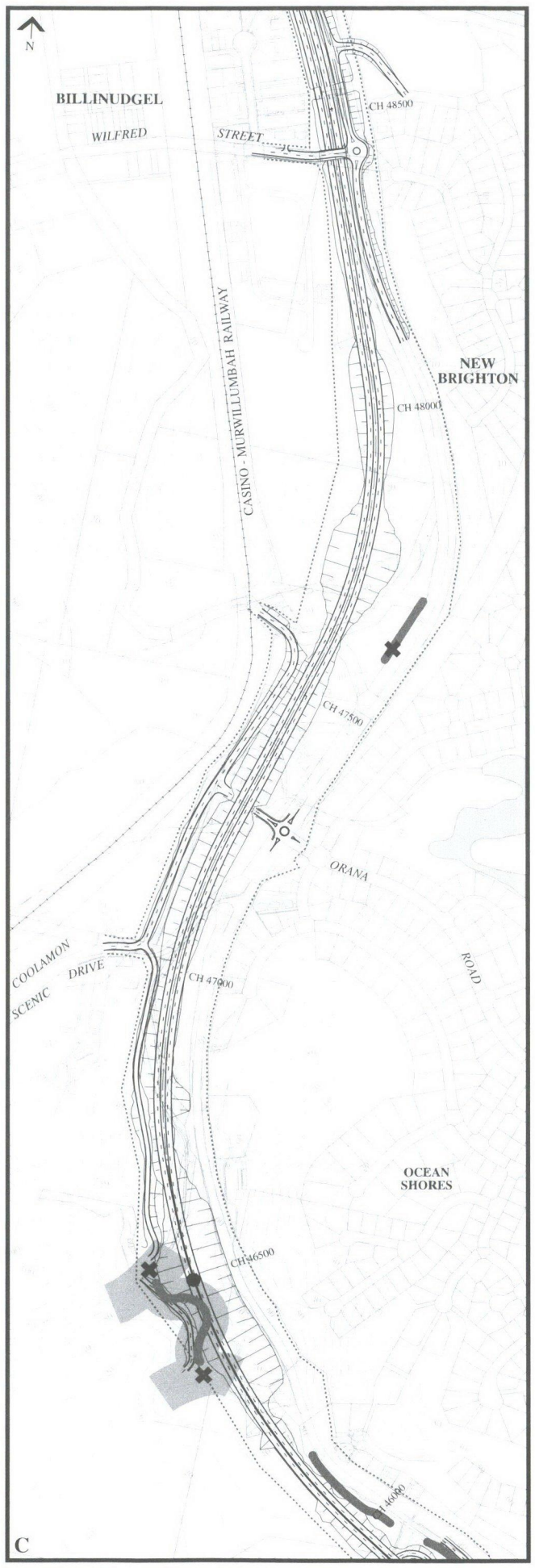
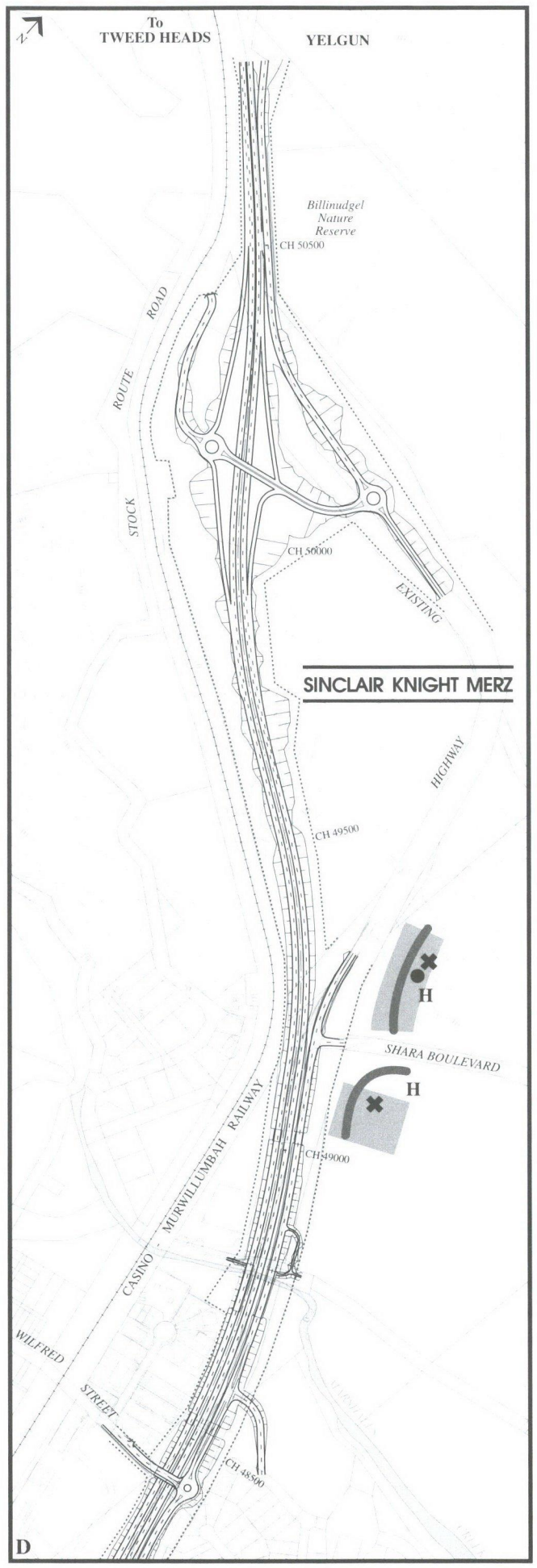
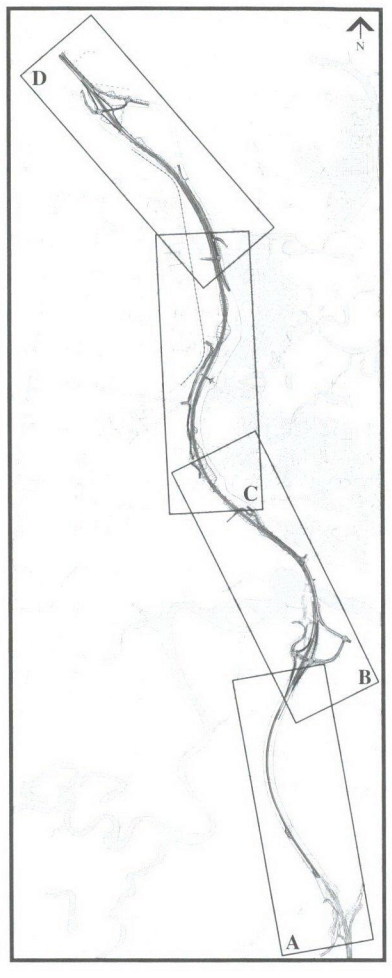






Legend

H	Harp Trap
	Trapline
P	Pitfall Line
	Dedicated Koala Scat Search
	Anabat Site
	Owl Survey Site
	Targeted surveys for Green and Golden Bell Frog
	Proposed Road Corridor

0 100 500m

Figure 6
LOCATION OF FAUNA SURVEY SITES

- the placement of one harp trap (targeting microchiropteran bats) at one location for five nights (the 20th to 24th of November 1997) along the proposed Bypass duplication alignment during the field surveys; and
- an assessment of the type and condition of the habitats present.

Supplementary surveys were undertaken in the Bypass study area on the 1st and 2nd of April 1998, targeting a few particular species which could occur in the area but which had not been recorded (Appendix 2). Activities included:

- call playback for the Eastern Grass Owl. A five-minute listening period was conducted, followed by 5 minute call playback, 5 minutes listening, 5 minutes call playback and finally a ten minute listening period; and
- call playback for the Green & Golden Bell Frog which was conducted at an artificial pond surrounded by Melaleuca forest in the Bypass study area. Spotlighting for amphibians was also conducted in creeklines along the Bypass over two nights.

3.2.2 Brunswick to Yelgun Upgrade

A number of investigations within the proposed study area were conducted prior to the detailed studies described below for the preferred route, to assess the study area for threatened flora and their habitats and to assess various route options for the proposed upgrade. Site inspections occurred from December 1996 regularly throughout 1997. The purposes of these visits were varied, but usually involved assessing the value of a particular area as habitat for fauna. The outcomes of these investigations assisted in determining the preferred route option.

Detailed field surveys were conducted along the preferred road corridor (Route A2) between the 18th and 23rd of November and between the 27th of November and the 3rd of December 1997. Supplementary surveys were also conducted on the 1st and 2nd of April 1998 to target specific species (detailed below). The field surveys for fauna along the Brunswick to Yelgun upgrade route involved:

- the placement of 9 traplines (Figure 6) within different areas of habitat, involving different numbers and proportions of the various traps used (Table 1.1 in Appendix 2). The Elliott traps and cage traps were set for four nights, whilst the hair-tubes were set for 12 to 41 nights;
- Elliott traps were set with a standard bait (peanut butter, honey and rolled oats mixture), whilst the cage traps were set with both vegetarian and meat (chicken parts) baits;
- tree-mounted Elliott traps were not utilised in Brunswick Heads or Billinudgel Nature Reserves, as requested by the NP&WS (L Tarvey NP&WS *pers comm*). The value of pit-trap sites was also hindered by constraints associated with Nature Reserves (see above), wet sites (resulting in flooded pits) and inappropriate habitats;
- the placement of 9 hair-tube lines along the traplines discussed above (Figure 6). The number of hair-tubes set at each location varied depending on the size of the patch of habitat. The hair tubes were set for 12 to 41 nights each, with a total of 3465 hair-tube nights along the upgrade during the surveys. Two different sized hair-tubes were utilised, with the intention of targeting different species. The hairs collected were sent to Ms M Bowen for identification;
- the setting of one pit-fall trapline (comprising 5 pits) south of the Brunswick River on the eastern side of the existing highway. The trap line was set for ten nights from the 20th to the 29th of November 1997 inclusive;
- the setting of Anabat II detectors at 8 different locations (Figure 6). Anabat detectors were set (on noise-activation mode) for one night at each location, over a three-night survey period (20th and 27th of November and the 1st of December 1997), for a period ranging between 2 hours and all night;

- thirty-one person-hours of spotlighting conducted at different locations along the upgrade route;
- diurnal bird, reptile and amphibian surveys conducted opportunistically for the duration of the time spent in the study area (15 days). Amphibians were mainly detected at night by their calls, but also through direct observation;
- the setting of harp traps at three locations (Figure 6) for 5-6 nights each (20th to the 24th of November or the 29th of November to the 3rd of December, 1997); and
- assessment of the types and condition of the habitats present.

Supplementary survey work was conducted on the 1st and 2nd of April 1988 to target threatened species which may occur in the study area, but which had not been recorded. Activities included:

- call playback targeting the Eastern Grass Owl over 2 nights at Billinudgel NR. A 5-minute listening period was conducted, followed by 5 minutes call playback, 5 minutes listening, 5 minutes call playback and finally a 10-minute listening period.
- dedicated searches at Marshall's Creek. An area 500m to the west of the highway and 750m to the east was covered in search of Australian and Black Bitterns and the Bush Hen on the night of the 1st of April, 1998; and
- assessment of the saltmarsh (just south of the Brunswick River) as potential habitat for the Jabiru.

3.3 PREVAILING WEATHER CONDITIONS

Weather conditions recorded during the GECon field investigations along the Brunswick Heads Bypass and upgrade routes are provided in Appendix 2.

Generally speaking, the weather conditions encountered during the November and December 1997 field surveys were relatively consistent, with little precipitation, calm to moderate winds, and warm to hot temperatures. Some intermittent showers occurred on the 18th of November, and steady rain fell on the evening of the 30th of November. Cloud cover was variable throughout the period.

Weather conditions experienced during the supplementary surveys (conducted in April 1998) included precipitation throughout the survey period, varying from scattered showers to heavy rain. Winds were calm to light, and temperatures were generally cooler. A heavy cloud cover was a consistent feature throughout this survey.

Given the considerable array of field investigations which have been previously conducted in the area, and the period over which they have been conducted (1992 to 1998), and given that the GECon investigations were conducted in a variety of weather conditions (Appendix 2), it is considered that the study area has been adequately surveyed during the full range of climatic and seasonal conditions.

4 FLORA

4.1 GENERAL FLORA

A total of 152 plant species were recorded within the proposed Bypass duplication study area (south of the Brunswick River), of which twenty were introduced species. No plant species listed as Endangered or Vulnerable under the TSC Act or ESP Act, or Rare or Threatened (ROTAP) in Briggs & Leigh (1996) were recorded in the Brunswick Heads Bypass study area, although four plant species considered to have regional conservation significance (DeVries 1997) were recorded within the proposed Bypass alignment.

A total of 271 plant species were recorded within the proposed Brunswick to Yelgun section, of which 21 were introduced species. Thirteen plant species of conservation significance were recorded, of which five are listed as Endangered (Schedule 1) and four as Vulnerable (Schedule 2) in the TSC Act. Of the nine threatened species (TSC Act), eight are also listed in the ESP Act (Commonwealth), with an additional four species listed as ROTAP species only (Table 4.4). Eleven plant species that are considered to have regional conservation significance (DeVries 1997) were also recorded in the study area.

4.2 BRUNSWICK HEADS BYPASS DUPLICATION

4.2.1 Vegetation Communities

Four separate vegetation communities were defined along the Bypass duplication alignment following analysis of the data collected during the flora surveys, in conjunction with the aerial photo interpretation of vegetation patterns. The four broad vegetation communities recorded include various associations or vegetation sub-units (Table 4.1).

The vegetation communities recorded along the Bypass duplication alignment are a subset of those recorded by Milledge & McKinley (1992), for the EIS prepared for the original Brunswick Heads Bypass Project. That investigation encompassed a substantial area of land south and east of the Brunswick River, involving a considerable number of vegetation communities which are not present along the duplication alignment (such as wetland and riverine communities).

The four broad vegetation communities include:

Map Unit 1 swamp sclerophyll forest and woodland;
Map Unit 2 dry sclerophyll forest;
Map Unit 3 remnant subtropical rainforest (and regrowth); and
Map Unit 4 cleared agricultural land and pasture.

Table 4.1 Plant communities occurring within the Brunswick Heads Bypass duplication study area.

MAP UNIT	VEGETATION COMMUNITIES
Unit 1	Swamp Sclerophyll Forest and Woodland
Sub-unit 1a	Paperbark *Melaleuca quinquenervia*
Sub-unit 1b	Swamp Mahogany *Eucalyptus robusta*
Sub-unit 1c	Swamp She-oak *Casuarina glauca*
Sub-unit 1d	Swamp Turpentine *Lophostemon suaveolens*
Unit 2	Dry Sclerophyll Forest Blackbutt *Eucalyptus pilularis*
Unit 3	Remnant Subtropical Rainforest Regrowth Red Kamala *Mallotus philippensis*
Unit 4	Pasture/Cleared

Mapping and descriptions of plant communities correspond closely with Milledge & McKinley (1992), with only minor differences resulting from API and ground-truthing, such as the separation of small areas of *Lophostemon suaveolens* and *Casuarina glauca* communities in the middle section of the route (Figure 7). The southern end of the route mapped by Milledge & McKinley (1992) as cleared/degraded Flooded Gum *E grandis* - Brush Box *Lophostemon confertus* was mapped in this study as remnant subtropical rainforest regrowth (Unit 3) and cleared pasture land (Unit 4).

MAP UNIT 1 SWAMP SCLEROPHYLL FOREST and WOODLAND

Swamp sclerophyll forest is the most common vegetation type in the study area, occupying low-lying, back-barrier swampland and much of the surrounding lower Brunswick River floodplain. Soils are formed on sand or alluvium, and low-lying stands have a peaty surface horizon produced by a seasonal surface water table, which inhibits vegetation decay. Four different swamp sclerophyll associations were recognised, dominated by *Melaleuca, Eucalyptus, Casuarina* and *Lophostemon* species.

1a Paperbark *Melaleuca quinquenervia*

Structure
Mid-high to tall open forest; mid-stratum usually sparse, but dense in one section where Broad-leaved Paperbark *M quinquenervia* is regenerating after fire; lower stratum 0.5-1.5 metres high; generally dense. Both rainforest (A) and sclerophyll (B) mid-strata are present in this community (see below).

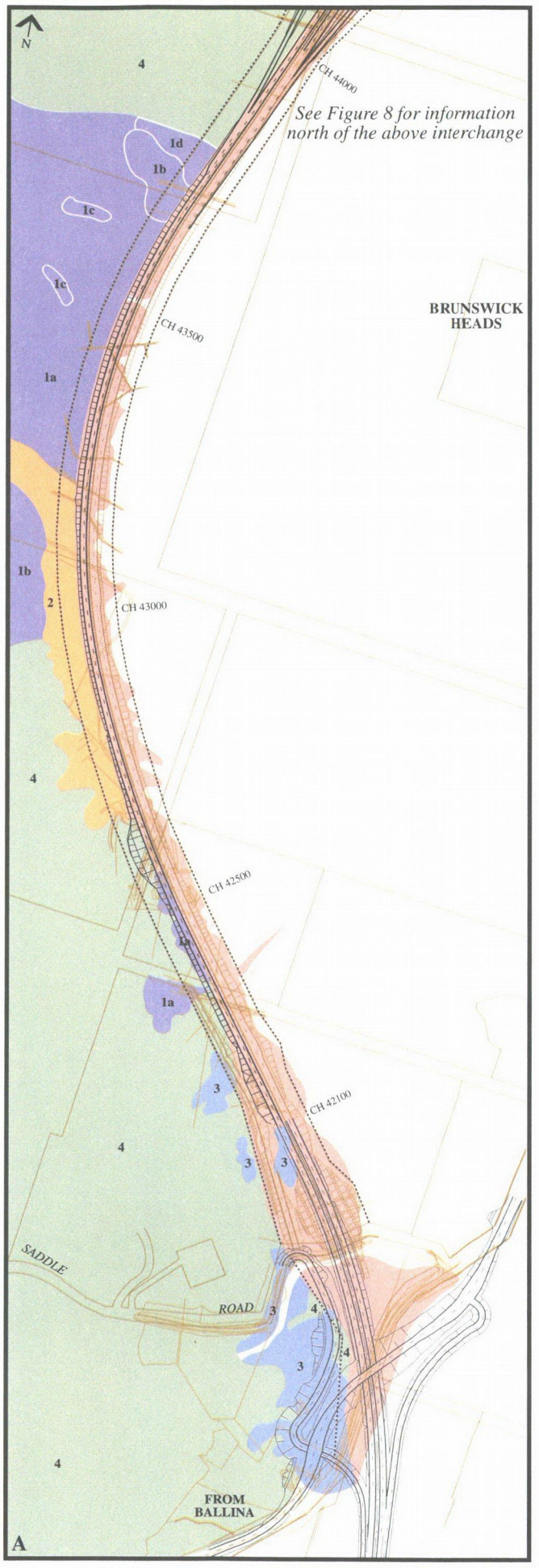
Habitat and Distribution
Flat terrain subject to seasonal waterlogging and inundation, with peaty soils formed on Pleistocene sands and recent sandy alluvium. A small stand at the base of hillslopes in the south of the area receives enrichment from colluvium and bedrock, contributing to the establishment of a swamp rainforest understorey. This vegetation type is mainly found in the southern and mid-sections of the route.

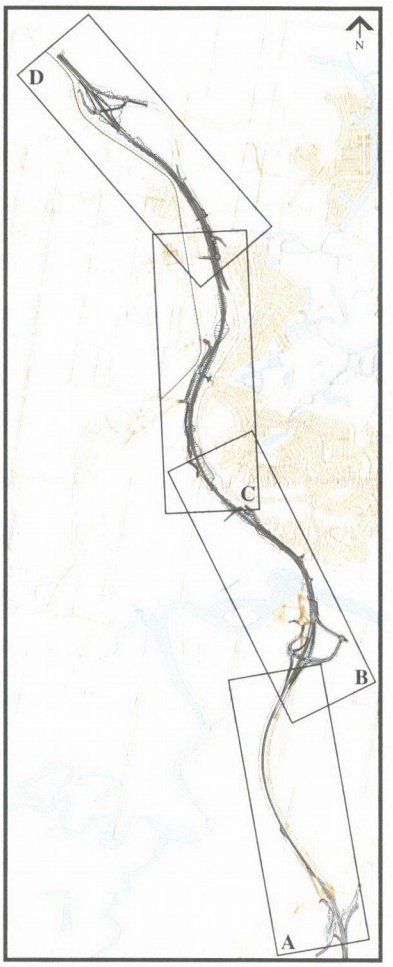
Condition
Examples within the study area are in fair condition, but are grazed and burnt, with a large area in the middle of the route apparently subject to a hot fire (3 to 5 years ago), which contributed to the death of many canopy trees.

LAYER (A)	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Broad-leaved Paperbark	*Melaleuca quinquenervia*	very common
Mid-stratum	Bangalow Palm	*Archontophoenix cunninghamii*	common
	Domatia Tree	*Endiandra discolor*	common
	Umbrella Cheese Tree	*Glochidion sumatranum*	common
	Straw Tree-fern	*Cyathea cooperi*	occasional
	Pink Euodia	*Melicope elleryana*	occasional
	Brush Muttonwood	*Rapanea howittiana*	occasional
Lower Stratum	Harsh Ground Fern	*Hypolepis muelleri*	very common
	Bats Wing Fern	*Histiopteris incisa*	common
	Elephants Ears	*Alocasia brisbanensis*	common

LAYER (B)	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Broad-leaved Paperbark	*Melaleuca quinquenervia*	very common
Mid-stratum	Broad-leaved Paperbark	*Melaleuca quinquenervia*	common
	Groundsel Bush	**Baccharis halimifolia*	common
	Climbing Fern	*Lygodium microphyllum*	common
	Cabbage Tree Palm	*Livistona australis*	occasional
Lower Stratum	Zig Zag Bog Rush	*Schoenus brevifolius*	common
	Tall Saw Sedge	*Gahnia clarkei*	common
	Bungwahl Fern	*Blechnum cartilagineum*	common
	Bracken Fern	*Pteridium esculentum*	occasional

* introduced species





Legend

Swamp Sclerophyll Forest and Woodland

- 1a Paperbark (*Melaleuca quinquenervia*)
- 1b Swamp Mahogany (*Eucalyptus robusta*)
- 1c Swamp She Oak (*Casuarina glauca*)
- 1d Swamp Terpentine (*Lophostemon suaveolens*)

Dry Sclerophyll Forest

- 2 Blackbutt (*Eucalyptus pilularis*)

Remnant Subtropical Rainforest Regrowth

- 3 Red Kamala (*Mallotus philippensis*)

Pasture/Cleared

- 4

Brunswick Heads Bypass open to traffic

0 100 500m

Figure 7
VEGETATION COMMUNITIES WITHIN THE BYPASS STUDY AREA

1b Swamp Mahogany *Eucalyptus robusta*

Structure
Mid-high to tall open forest to open woodland; mid-stratum sparse to mid-dense; lower stratum 0.5-1.5 metres high; generally dense.

Habitat and Distribution
Flat terrain on humic sandy loams with a high water table; at slightly higher elevation than community 1a. The proposed alignment intersects a small section of an extensive stand in the southern half of the route and additional small areas in the northern half.

Condition
Good condition. Recently burnt, but regenerating well.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Swamp Mahogany	*Eucalyptus robusta*	common
	Broad-leaved Paperbark	*Melaleuca quinquenervia*	common
Mid-stratum	Broad-leaved Paperbark	*Melaleuca quinquenervia*	common
	White's Teatree	*Leptospermum whitei*	common
	Willow Bottlebrush	*Callistemon salignus*	common
	Weeping Baeckea	*Baeckea stenophylla*	common
	Satinwood	*Phebalium squameum*	common
	Golden Shaggy Pea	*Oxylobium robustum*	occasional
	Red-fruited Saw Sedge	*Gahnia sieberiana*	occasional
Lower Stratum	Feather Plant	*Restio tetraphyllus*	common
	Flat-leaved Mat Rush	*Lomandra longifolia*	common

1c Swamp She-oak *Casuarina glauca*

Structure
Mid-high to tall open forest or woodland; mid-stratum sparse; lower stratum dense.

Habitat and Distribution
Low-lying terrain adjacent to mangroves or saltmarsh and probably subject to some saline influence during king high tides. The study area intersects small stands at the northern end of the route and in the centre of the route along a tidal creek. A small area of this community in the centre of the route, outside the fenced corridor, borders the upper reaches of a small tidal creek lined with Grey Mangrove *Avicennia marina* var *australasica* and River Mangrove *Aegiceras corniculata*, which were not separated as a distinct community because of their limited extent.

Condition
Generally good with limited disturbance by cattle grazing.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Swamp She-oak	*Casuarina glauca*	very common
Mid-stratum	Common Silkpod Vine	*Parsonsia straminea*	common
	Boobialla	*Myoporum acuminatum*	occasional
Lower Stratum	Salt Rush	*Juncus krausii* var *australis*	very common
	Grass	*Echinochloa telmatophila*	occasional
	Zig Zag Bog Rush	*Schoenus brevifolius*	occasional

1d Swamp Turpentine *Lophostemon suaveolens*

Structure
Mid-high to tall open forest; mid-stratum absent; lower stratum mid-dense.

Habitat and Distribution
Occurs at slightly higher elevation than Map unit 1a and Map unit 1b on similar low-lying terrain with a high water table. One small area of this community was identified in the middle section of the route.

Condition
Good; upper stratum undisturbed; lower stratum with a long history of grazing.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Swamp Turpentine	*Lophostemon suaveolens*	common
Lower Stratum	Carpet Grass	**Axonopus affinis*	common
	Sedge	*Cyperus* spp	common
	Sedge	*Fimbristylis dichotoma*	occasional
	Hairy Bush Pea	*Pultenaea villosa*	occasional
	Tall Saw Sedge	*Gahnia clarkei*	occasional
	Goodenia	*Goodenia paniculata*	occasional
	Blady Grass	*Imperata cylindrica*	occasional
	Running Postman	*Kennedia rubicunda*	occasional

* introduced species

MAP UNIT 2 DRY SCLEROPHYLL FOREST

2a Blackbutt *Eucalyptus pilularis*

Structure
Tall open forest; mid-stratum sparse; lower stratum mid-dense to dense.

Habitat and Distribution
Occurs in a band of sandy soil on slightly higher ground along the southern half of the route.

Condition
Fair; mature canopy intact, but understorey disturbed by works associated with the original carriageway.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Blackbutt	*Eucalyptus pilularis*	very common
Mid-stratum	Sally Wattle	*Acacia melanoxylon*	common
	Blueberry Ash	*Elaeocarpus reticulatus*	common
	Shrubby Platysace	*Platysace lanceolata*	occasional
	Smooth Cheese Tree	*Glochidion ferdinandi* var *ferdinandi*	occasional
	Pearl Beard Heath	*Leucopogon margarodes*	occasional
	Satinwood	*Phebalium squameum*	occasional
Lower Stratum	Flat-leaved Mat Rush	*Lomandra longifolia*	common
	Bracken Fern	*Pteridium esculentum*	common
	Pomax	*Pomax umbellata*	common
	Midgenberry	*Austromyrtus dulcis*	common
	Teatree Beard Heath	*Leptospermum leptospermoides*	occasional
	Twining Guinea Flower	*Hibbertia scandens*	occasional

MAP UNIT 3 REMNANT SUBTROPICAL RAINFOREST REGROWTH

Small patches of subtropical rainforest regrowth, dominated by Red Kamala *Mallotus philippensis* and other secondary rainforest species, are located at the southern end of the study area, growing on krasnozem soil formed on basalt.

- Red Kamala *Mallotus philippensis*

Structure
Mid-high open forest; mid-stratum sparse; lower stratum sparse to mid-dense.

Habitat and Distribution
Patches of subtropical rainforest regrowth occur in cleared pasture and on the east-facing slope at the southern end of the Bypass, growing on krasnozem soil formed on basalt. This soil type would have originally supported sub-tropical rainforest.

Condition
Poor; patches are often weed-infested, small in area and low in diversity.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Red Kamala	*Mallotus philippensis*	common
	Macaranga	*Macaranga tanarius*	common
	Rough-leaved Elm	*Aphananthe philippinensis*	occasional
	Sally Wattle	*Acacia melanoxylon*	occasional
	Pink Euodia	*Melicope elleryana*	occasional
	Actephila	*Actephila lindleyi*	occasional
Mid-stratum	Lantana	**Lantana camara*	common
	Tobacco Bush	**Solanum mauritianum*	common

* introduced species

MAP UNIT 4 CLEARED/PASTURE

Vegetation at the northern and southern ends of the study area is mainly cleared pasture dominated by introduced grasses such as Kikuyu (on krasnozem soils only), Carpet Grass *Axonopus affinis*, Vasey Grass *Paspalum urvillei* and South African Pigeon Grass *Setaria sphacelata*, and other introduced herbaceous weeds.

4.2.2 Plant Species of Conservation Significance

No rare or threatened plants (Briggs & Leigh 1996) or Endangered or Vulnerable species listed under either the TSC Act or the ESP Act were recorded during the survey for the proposed Brunswick Heads Bypass duplication. Conversely, four regionally significant species (DeVries 1997) were recorded in the study area. Several additional species listed by Sheringham & Westaway (1995) were also recorded along the Bypass duplication study area, although these species are not regarded as of concern at the State or National level, nor are they listed by DeVries (1997) as of regional significance. Furthermore, none of the additional species listed by Sheringham & Westaway (1995) are likely to be restricted to the area proposed for the Bypass duplication.

- Mangrove Fern *Acrostichum speciosum*

Specimens of this species were recorded along a small tidal creek in the middle section of the route about 30 metres to the west of the fenced corridor. This species is found across northern Australia, into southeast Asia and reaches its southern limit on the far north coast of NSW, extending as far south as Iluka. This species is described as rare by Harden (1991) and geographically significant by Sheringham & Westaway (1995).

The Mangrove Fern is not uncommon on the edge of mangroves in the lower Brunswick River estuary, but has a limited ecological range on less saline sites. Also found along Simpson's Creek (Tyagarah NR) and Marshall's Creek (proposed additions to the Brunswick Heads NR).

- White's Teatree *Leptospermum whitei*

Once considered to be rare, this species is in fact locally common in far northeast NSW and southeast Queensland. It is common in Tyagarah Nature Reserve and on Crown Land west of the town of Brunswick Heads (Benwell 1997e).

- *Cyperus haspan* ssp *juncoides*

This species is listed by Sheringham & Westaway (1995) as regionally significant due to its being at the southern end of its range at Evans Head (Harden 1992). It is known to be reserved locally in Billinudgel Nature Reserve.

- Burny Bean *Mucuna gigantea*

Burny Bean is a leguminous vine with striking green flowers which hang by a long stalk in rings resembling small chandeliers. It is listed by Sheringham & Westaway (1995) as a significant species due to depleted or sparse habitat and possible under-representation in conservation reserves.

A stand of paperbarks bordering the road construction in the south of the study area has a dense growth of this rainforest climber, which reaches a height of about 15m. This stand has avoided clearing during construction along the edge of the present Bypass, evidently to screen a property. However, a proportion of the stand may require clearing as a result of any westerly extension for the four-lane road.

4.2.3 Conservation Significance of Vegetation Communities

In order to assess their regional conservation significance within the study area, vegetation communities have been correlated with vegetation types recognised in broad classifications for the region (Table 4.2). The State Forests' system of classification of vegetation types was used, with subsequent translation into equivalent communities in the Hager & Benson (1994) classification for northern NSW. This latter classification system attempts to assess the extent to which different vegetation communities are represented in conservation reserves.

Table 4.2 Conservation status of vegetation communities located within the study area for the proposed Brunswick Heads Bypass duplication.

COMMUNITY	CONSERVATION STATUS
Vegetation Unit 1: Swamp Sclerophyll Forest and Woodland	
1a Paperbark *Melaleuca quinquenervia*	Forest Type 31 - Paperbark (FCNSW 1989); WT 101- Between 10% and 25% conserved. Rated 3 (inadequately conserved), because major parts of its geographic range remain poorly protected, despite moderate areas being located in reserves (Hager & Benson 1994). "*widespread on the North & Central Coasts*" (Griffith 1993).
1b Swamp Mahogany *Eucalyptus robusta*	Forest Type 30 - Swamp Mahogany (FCNSW 1989); EF 202 - Between <10% and <25% conserved. Rated 3 (inadequately conserved) (Hager & Benson 1994), despite levels of conservation. Regarded as well reserved over parts of its range, "*south of the Evans River, but not so elsewhere*", including in the study area (Griffith 1993).
1c Swamp She-oak *Casuarina glauca*	Forest Type 32 - Swamp Oak (FCNSW 1989); WT 101 - Rated 4 (undetermined), because additional information on the size of an adequate sample is required (Hager & Benson 1994). Conversely, "*many stands are designated under SEPP 14 - Coastal Wetlands*" (Griffith 1993).
1d Swamp Turpentine *Lophostemon Suaveolens*	Not considered by Hager & Benson (1994). This community is "*only reserved as minor areas*" (Griffith 1993).
Vegetation Unit 2: Dry Sclerophyll Forest	
2a Blackbutt *Eucalyptus pilularis*	Forest Type 37 - Dry Blackbutt (FCNSW 1989); EF 115 - Between 10% and 25% conserved. Rated 3 (inadequately conserved), because major parts of the geographic range remain poorly protected (Hager & Benson 1994), despite moderate areas being located in reserves.
Vegetation Unit 3: Remnant Subtropical Rainforest Regrowth	
Red Kamala *Mallotus philippensis*	Not classified, as this community is highly disturbed.

For example, the swamp sclerophyll forest and woodland (Units 1a and 1b) of the study area equate to Forest Type 31 (Paperbark) and Forest Type 30 (Swamp Mahogany) of the FCNSW (1989) classification respectively, and to WT 101 and to EF 202 in the Hager & Benson (1994) classification respectively.

The conservation status and distribution of many of the coastal vegetation communities are also considered by Griffith (1993), and included in Table 4.2 where available.

4.3 BRUNSWICK to YELGUN UPGRADE

4.3.1 Vegetation Communities

Analysis of data collected during the field flora surveys, in conjunction with the available aerial photograph and topographic mapping, revealed seven broad vegetation communities within the Brunswick to Yelgun upgrade study area (Figure 8). Seventeen vegetation associations or sub-units are included in the seven broad vegetation communities (Table 4.3).

Table 4.3 Vegetation communities and associations occurring within the proposed Brunswick to Yelgun upgrade study area.

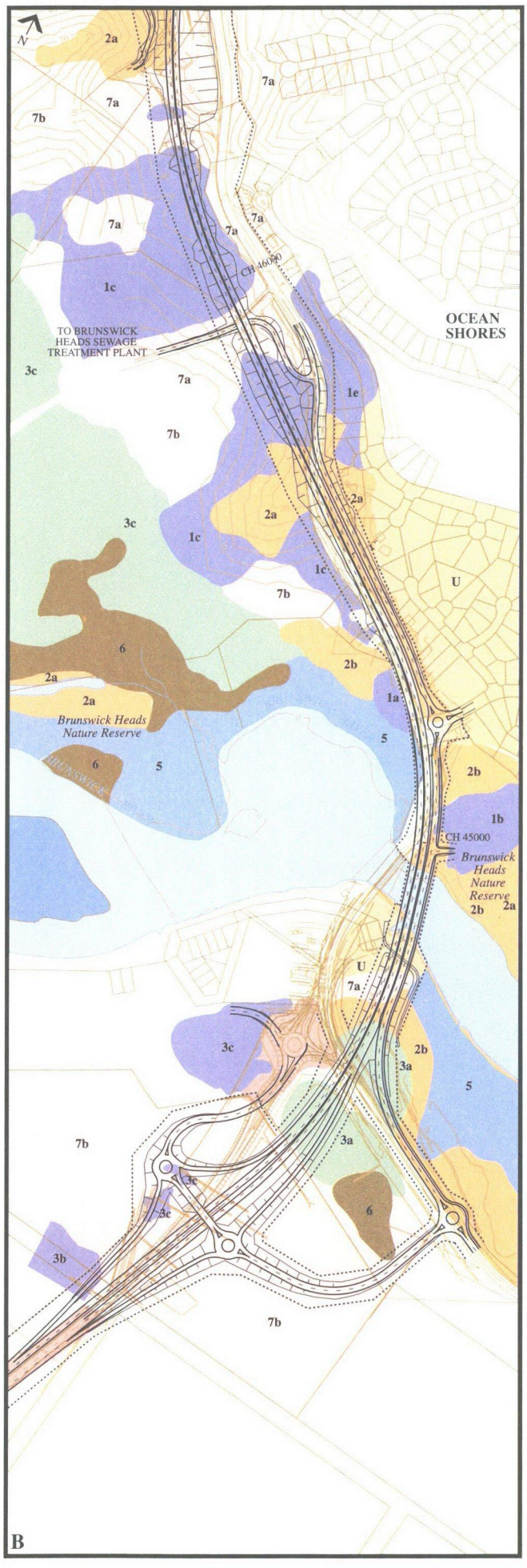
MAP UNIT	VEGETATION COMMUNITY
Unit 1	Rainforest
Sub-unit 1a	Subtropical rainforest on alluvium
Sub-unit 1b	Subtropical rainforest on metasediment
Sub-unit 1c	Regrowth subtropical rainforest on metasediment
Sub-unit 1d	Gallery dry rainforest
Sub-unit 1e	Regrowth dry rainforest on basalt
Unit 2	Wet Sclerophyll Forest
Sub-unit 2a	Brush Box *Lophostemon confertus*
Sub-unit 2b	Forest Red Gum *Eucalyptus tereticornis*
Sub-unit 2c	Blackbutt *Eucalyptus pilularis*
Sub-unit 2d	Broad-leaved Ironbark *Eucalyptus siderophloia* - Tallow-wood *Eucalyptus microcorys* - Pink Bloodwood *Corymbia intermedia*
Unit 3	Swamp Sclerophyll Forest
Sub-unit 3a	Broad-leaved Paperbark *Melaleuca quinquenervia*
Sub-unit 3b	Swamp Mahogany *Eucalyptus robusta*
Sub-unit 3c	Swamp Oak *Casuarina glauca*
Unit 4	Sedgeland Saw Sedge *Cyperus lucidus* - Articulated Rush *Baumea articulata*
Unit 5	Mangroves Grey Mangrove *Avicennia marina* var *australasica* - River Mangrove *Aegiceras corniculata*
Unit 6	Saltmarsh Saltwater Couch *Sporobolus virginicus* var *minor*
Unit 7	Pioneer Forest Regrowth/Cleared
Sub-unit 7a	Sally Wattle *Acacia melanoxylon*- Camphor Laurel *Cinnamomum camphora*
Sub-unit 7b	Cleared grassland or Lantana *Lantana camara* shrubland with scattered trees.

A description of each of the 17 vegetation sub-units is provided below, with details of the vegetation type structure and the most frequent species occurring in each layer (Upper Stratum, Mid-stratum, and Lower Stratum) as well as information indicating the distribution of each vegetation type on and adjacent to the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

VEGETATION UNIT 1 RAINFOREST

1a Subtropical Rainforest on Alluvium

Structure
Very tall (20-30m) closed forest.


N
2a
7a
7b
7a
7a
7a
CH 46000
1c
TO BRUNSWICK HEADS SEWAGE TREATMENT PLANT
OCEAN SHORES
3c
7a
1e
7b
2a
2a
3c
1c
1c
U
7b
6
2b
2a
2a
1a
Brunswick Heads Nature Reserve
5
6
5
BRUNSWICK
2b
1b
CH 45000
Brunswick Heads Nature Reserve
2b
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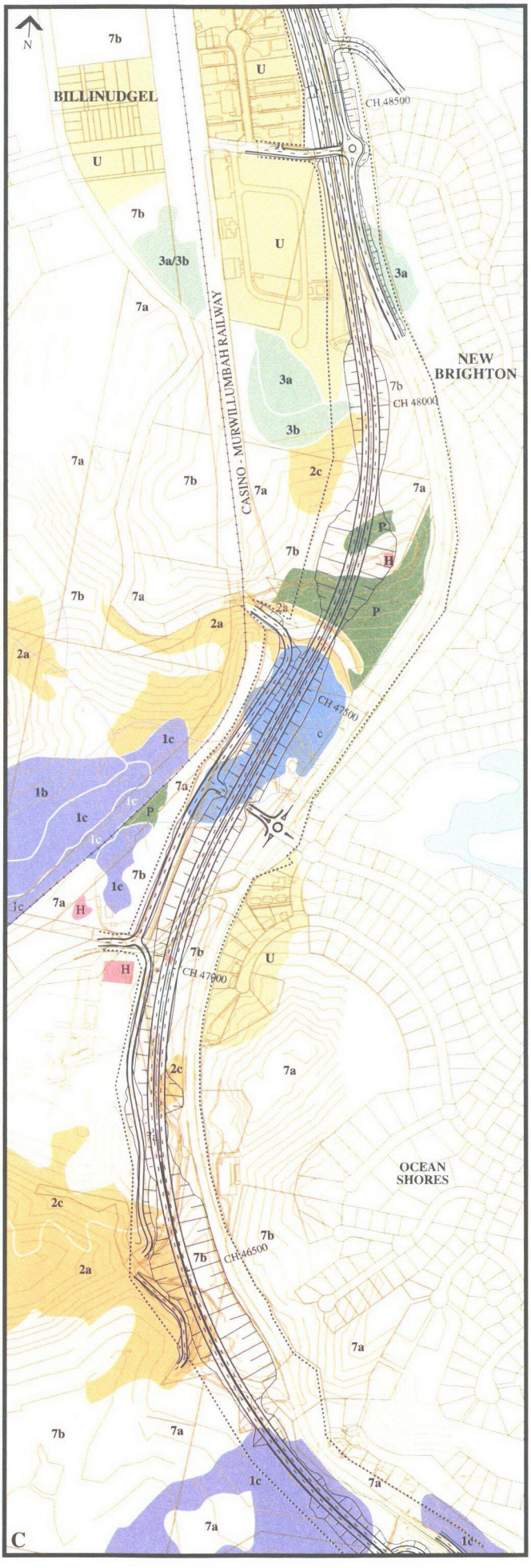
N
7b
BILLINUDGEL
U
U
CH 48500
7b
U
3a/3b
3a
7a
CASINO - MURWILLUMBAH RAILWAY
NEW BRIGHTON
3a
7b
CH 48000
3b
7a
7b
7a
2c
7a
P
7b
H
7b
7a
P
2a
2a
2a
CH 47500
c
1c
1b
7a
1c
P
1c
1c
7b
1c
7a
H
7b
H
CH 47900
U
2c
7a
OCEAN SHORES
2c
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7b
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7a
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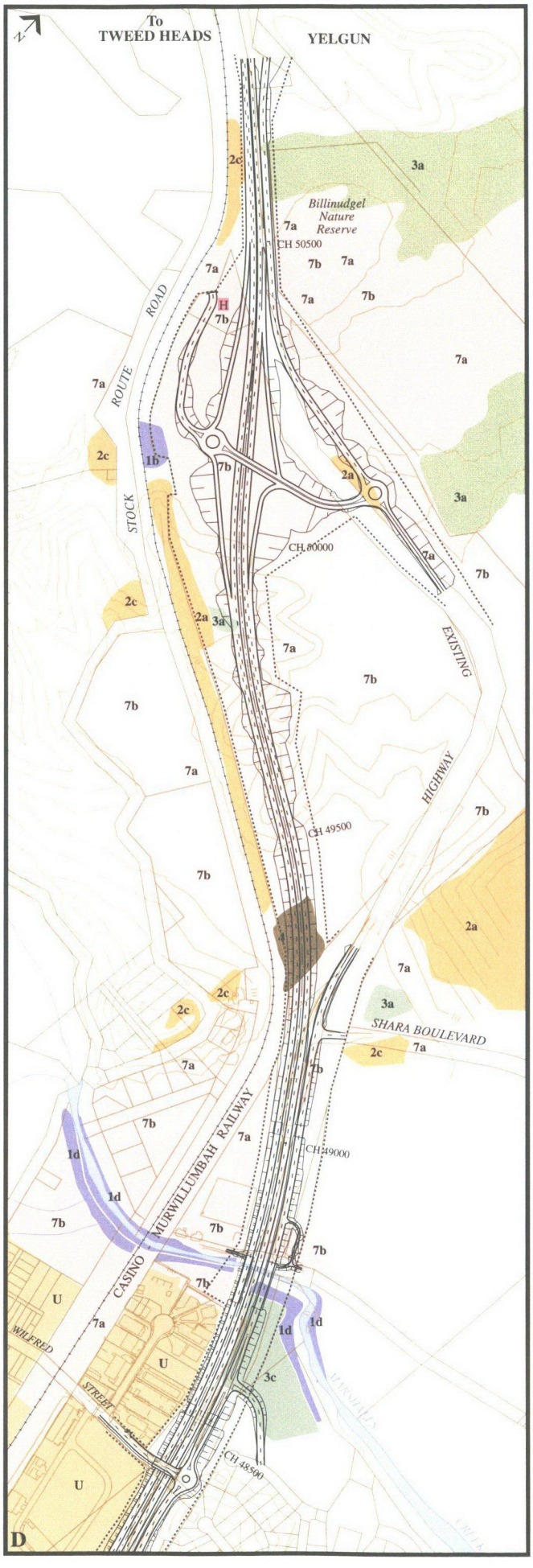




Legend

- P Pasture
- H House
- U Urban/Commercial
- C Cleared

Rainforest

- 1a Subtropical rainforest on alluvium
- 1b Subtropical rainforest on metasediment
- 1c Regrowth subtropical rainforest on metasediment
- 1d Gallery dry rainforest
- 1e Regrowth dry rainforest on basalt

Wet Sclerophyll Forest

- 2a Brush Box (*Lophostemon confertus*)
- 2b Forest Red Gum (*Eucalyptus tereticornis*)
- 2c Blackbutt (*Eucalyptus pilularis*)
- 2d Broad-leaved Ironbark (*Eucalyptus siderophloia*)
  Tallow-wood (*Eucalyptus microcorys*) - Pink Bloodwood (*Corymbia intermedia*)

Swamp Sclerophyll Forest

- 3a Broad-leaved Paperback (*Melaleuca quinquenervia*)
- 3b Swamp Mahogany (*Eucalyptus robusta*)
- 3c Swamp Oak (*Casuarina glauca*)

Sedgeland

- 4 Saw Sedge (*Cyperus lucidus*) - Articulated Rush (*Baumea articulata*)

Mangroves

- 5 Grey Mangrove (*Avicennia marina var australasica* —) River Mangrove (*Aegiceras corniculata*)

Saltmarsh

- 6 Saltwater Couch (*Sporobolus virginicus var minor*)

Pioneer Forest Regrowth/Cleared

- 7a Sally Wattle (*Acacia melanoxylon*) — Camphor Laurel (*Cinnamomum camphora*)
- 7b Cleared Grassland or Lantana (*Lantana camara*) shrubland with scattered trees

..... Proposed Road Corridor

0 100 500m

Figure 8
VEGETATION COMMUNITIES WITHIN THE UPGRADE STUDY AREA

Habitat and Distribution
Restricted to a small area of floodplain on the western side of the existing highway in Brunswick Heads NR. The soil is a dark clay-loam formed on recent alluvium overlying Pleistocene marine-aeolian sand.

Condition
Good. Mature rainforest with little evidence of disturbance or weed invasion, except along the edge adjoining the existing highway.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	White Yiel Yiel	*Grevillea hilliana*	common
	Hoop Pine	*Araucaria cunninghamii*	common
	Bennett's Ash	*Flindersia bennettiana*	common
	Myrtle Ebony	*Diospyros pentamera*	common
	Rough-leaved Elm	*Aphananthe philippinensis*	common
	Blush Walnut	*Beilschmiedia obtusifolia*	occasional
Mid-stratum	Yellow Pear Fruit	*Mischocarpus pyriformis*	common
	Cleistanthus	*Cleistanthus cunninghamii*	common
	Southern Lawyer Vine	*Calamus muelleri*	common
	Grey Ebony	*Diospyros fasciculosa*	occasional
	Spiny Gardenia	*Randia moorei* TSC Act Sch1	occasional
	Twin-leaf Coogera	*Arytera dystylis*	occasional
Lower Stratum	Shiny Shield Fern	*Lastreopsis acuminata*	common
	Oplismenus	*Oplismenus imbecillis*	common
	White Supplejack	*Ripogonum album*	common

1b Subtropical Rainforest on Metasediment

Structure
Very tall (20-35m) closed forest.

Habitat and Distribution
This community occurs on sheltered southeast to southwest-facing slopes on metasedimentary geology at two locations:

- west of the Salad Bowl Caravan Park and railway line; and
- on the eastern side of the existing highway in Brunswick Heads NR.

Condition
Good. Rainforest with no weed invasion or other signs of disturbance except on the forest margin.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Hoop Pine	*Araucaria cunninghamii*	common
	Blush Coondoo	*Planchonella laurifolia*	common
	Rose Marara	*Pseudoweinmannia lachnocarpa*	common
	Blackbean	*Castanospermum australe*	common
	Cudgerie	*Flindersia schottiana*	common
	Mango Bark	*Canarium australasicum*	common
	Red Bean	*Dysoxylum mollissimum*	common
	White Booyong	*Heriteria trifoliatum*	common
	Morton Bay Fig	*Ficus macrophylla* subsp *macrophylla*	occasional
	Strangler Fig	*Ficus watkinsiana*	occasional
	Grey Walnut	*Beilschmedia elliptica*	occasional
Mid Stratum	Bangalow Palm	*Archontophoenix cunninghamiana*	common
	Black Walnut	*Endiandra globosa*	common
	Southern Lawyer Vine	*Calamus muelleri*	common
	White Bolly Gum	*Neolitsea dealbata*	common
	Blush Coondoo	*Planchonella laurifolia*	common
	Blackbean	*Castanospermum australe*	common
	Steelwood	*Sarcopteryx stipata*	common
	Veiny Laceflower	*Archidendron muellerianum*	occasional
Lower Stratum	Shiny Shield Fern	*Lastreopsis acuminata*	common
	Blunt Shield Fern	*Lastreopsis marginans*	common
	Rough Maidenhair Fern	*Adiantum hispidulum*	common
	Prickly Tree-fern	*Cyathea leichhardtiana*	common
	Walking Stick Palm	*Linospadix monostachys*	common
	Fissistigma	*Ancana stenopetala*	common

1c Regrowth Subtropical Rainforest on Metasediment

Structure
Mid-high to very tall (12-25m) open to closed forest.

Habitat and Distribution
Occurs on protected east to south-facing slopes at two locations:

- between the existing highway and the sewage treatment plant; and
- on the footslopes and floodplain near the Salad Bowl Caravan Park, on both sides of the railway line.

Condition
Varies from good to poor, depending on the degree of structural development, species diversity and weed-infestation. This community probably represents 30-50 years of regrowth, and appears to occur on sites where rainforest was disturbed without eliminating all original rainforest plants or their seedbanks. Species diversity is usually much reduced compared to community 1b, but the presence of seedlings and saplings of a wide range of species indicates seed dispersal from adjacent mature rainforest and the potential for gradual re-establishment of the original species composition.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Hoop Pine	*Araucaria cunninghamii*	common
	Guioa	*Guioa semiglauca*	common
	Camphor Laurel	*Cinnamomum camphora*	common
	Sally Wattle	*Acacia melanoxylon*	common
	Brush Kurrajong	*Commersonia bartramia*	common
	Red Kamala	*Mallotus philippensis*	common
	Cudgerie	*Flindersia schottiana*	occasional
	Riberry	*Syzygium luehmanii*	occasional
	Jackwood	*Cryptocarya glaucescens*	occasional
Mid-stratum	Rose Myrtle	*Archirhodomyrtus beckleri*	common
	Scentless Rosewood	*Synoum glandulosum*	common
	* Lantana	*Lantana camara*	common
	Peach Myrtle	*Pilidiostigma glabrum*	common
	Cockspur	*Maclura cochinchinensis*	occasional
	Davidson's Plum	*Davidsonia pruriens* ssp *jerseyana*	occasional
	Sweet Pittosporum	*Pittosporum undulatum*	occasional
	Black Walnut	*Endiandra globosa*	occasional
	Macaranga	*Macaranga tanarius*	occasional
Lower Stratum	* Mist Flower	*Ageratina riparia*	common
	* Sour Grass	*Paspalum conjugatum*	common
	* Bracken Fern	*Pteridium esculentum*	common
	Saw Sedge	*Gahnia aspera*	occasional

* introduced species

1d Gallery Dry Rainforest

Structure
Mid-high to very tall (12-25m) open to closed forest.

Habitat and Distribution
On alluvium overlying sand, on natural levees either side of Marshall's Creek near Billinudgel.

Condition
Fair. A remnant community which has been reduced to a narrow strip along Marshall's Creek surrounded by cleared land and development. Weed-infestation is moderately high, due to clearing of adjacent areas.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Hoop Pine	*Araucaria cunninghamii*	common
	Hard Quandong	*Elaeocarpus obovatus*	common
	Guioa	*Guioa semiglauca*	common
	Coastal Hickory Wattle	*Acacia aulacocarpa*	common
	Sally Wattle	*Acacia melanoxylon*	common
	Brush Kurrajong	*Commersonia bartramia*	common
	Swamp She-oak	*Casuarina glauca*	occasional
	Giant Water Gum	*Syzygium francisii*	occasional
Mid-stratum	Tuckeroo	*Cupaniopsis anacardioides*	common
	* Lantana	*Lantana camara*	common
	* Winter Senna	*Senna pendula* var *glabrata*	common
	Common Mock Olive	*Notelaea longifolia*	occasional
	River Mangrove	*Aegiceras corniculata*	occasional
	Coast Canthium	*Canthium coprosmoides*	occasional
	Prickly Alyxia	*Alyxia ruscifolia*	occasional
	Hoya	*Hoya australis*	occasional
	Whip Vine	*Flagellaria indica*	occasional
	Yellow Tulip	*Drypetes australasica*	occasional
Lower Stratum	* Wandering Jew	*Tradescantia albiflora*	common
	Ottochloa	*Ottochloa gracillima*	common

* introduced species

1e Regrowth Dry Rainforest on Basalt

Structure
Mid-high open to closed forest.

Habitat and Distribution
Occurs on an upper south-facing slope at the top of a cutting on the Ocean Shores hill and on an exposed east-facing slope adjoining the public utilities area on the same hill. Soils are chocolate loams formed on basalt or basaltic colluvium.

Condition
Fair to poor. The stand above the highway cutting is a remnant strip disturbed by previous highway building and development. The stand next to the utilities area has also been heavily disturbed. Stands are in an early stage of regrowth and have moderate levels of weed-infestation, but retain a distinctive dry rainforest composition.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Macaranga	*Macaranga tanarius*	common
	Rough-leaved Elm	*Aphananthe philippinensis*	common
	Whalebone Tree	*Streblus brunonianus*	common
	Three-veined Laurel	*Cryptocarya triplinervis*	common
	Sally Wattle	*Acacia melanoxylon*	common
	Red Kamala	*Mallotus philippensis*	common
	* Camphor Laurel	*Cinnamomum camphora*	common
	* Privet	*Ligustrum lucidum*	occasional
	Morton Bay Fig	*Ficus macrophylla* var *macrophylla*	occasional
	* Lantana	*Lantana camara*	common
Mid-stratum	Cockspur	*Maclura cochinchinensis*	common
Lower Stratum	poorly differentiated		

* introduced species

VEGETATION UNIT 2 WET SCLEROPHYLL FOREST

2a Brush Box *Lophostemon confertus*

Structure
Tall to very tall (20-35m) open forest; mid-stratum mid-dense; lower stratum mid-dense.

Habitat and Distribution
Common in the survey area on southeast to southwest-facing slopes on metasedimentary geology. Soils are red-yellow podzolics formed on deeply weathered chert and phyllite, sometimes enriched by basaltic colluvium. This community also occurs on floodplain sediments overlying sand, southeast of the sewage treatment plant.

Condition
Stand condition varies from good to fair, depending on the degree of past disturbance. Stands on the floodplain east of the sewage treatment plant and on steep slopes surrounding the known Hairy Quandong *Elaeocarpus williamsianus* population are in good condition, with mature or old-growth trees and few weeds. Other stands have been heavily disturbed and support early to advanced stage regrowth with light to moderate infestations of Lantana *Lantana camara* and Camphor Laurel *Cinnamomum camphora*. However, species composition is diverse and several rare, threatened and/or regionally significant plant species are present.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Brush Box	*Lophostemon confertus*	very common
	Tallow-wood	*Eucalyptus microcorys*	occasional
	Pink Bloodwood	*Corymbia intermedia*	occasional
	Blackbutt	*Eucalyptus pilularis*	occasional
	* Camphor Laurel	*Cinnamomum camphora*	occasional
Mid-stratum	Guioa	*Guioa semiglauca*	common
	Black Walnut	*Endiandra globosa* (R)	common
	Prickly Treefern	*Cyathea leichhardtiana*	common
	Murrogun	*Cryptocarya microneura*	common
	Tree Heath	*Trochocarpa laurina*	common
	Scentless Rosewood	*Synoum glandulosum*	common
	Veiny Wilkea	*Wilkea huegliana*	common
	Plum Myrtle	*Pilidiostigma glabrum*	common
	* Lantana	*Lantana camara*	common
	Jackwood	*Cryptocarya glaucescens*	occasional
	Caldcluvia	*Caldcluvia paniculosa*	occasional
Lower Stratum	Gristle Fern	*Blechnum cartilagineum*	common
	Native Ginger	*Alpinia caerulea*	common
	Rough Maidenhair Fern	*Adiantum hispidulum*	common
	Rasp Fern	*Doodia aspera*	common
	Smilax	*Smilax australis*	common
	Common Ground Fern	*Calochlaena dubia*	common

* introduced species

R ROTAP species

2b Forest Red Gum *E tereticornis*

Structure
Tall to very tall (15-30m) open forest; mid-stratum mid-dense to dense; lower stratum dense.

Habitat and Distribution
Gently sloping footslopes and floodplain north and south of the Brunswick River. The soil is a clay-loam formed on alluvium overlying sand and on metasedimentary colluvium.

Condition
Good. Mature trees and minor weed-infestation.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Forest Red Gum	*Eucalyptus tereticornis*	common
	Pink Bloodwood	*Corymbia intermedia*	occasional
	Flooded Gum	*Eucalyptus grandis*	occasional
Mid-stratum	Umbrella Cheese Tree	*Glochidion sumatranum*	common
	Brush Ironbark Wattle	*Acacia aulacocarpa*	common
	Tuckeroo	*Cupaniopsis anacardioides*	common
	Sally Wattle	*Acacia melanoxylon*	common
	Five-leaf Water Vine	*Cissus hypoglauca*	common
	Yellow Tulip	*Drypetes australasica*	occasional
	Grey Ebony	*Diospyros fasciculosa*	occasional
	Cudgerie	*Flindersia schottiana*	occasional
	Celerywood	*Polyscias elegans*	occasional
	Brush Muttonwood	*Rapanea howittiana*	occasional
	Lilly Pilly	*Acmena smithii*	occasional
	Pink Euodia	*Melicope elleryana*	occasional
	Blue Lilly Pilly	*Syzygium oleosum*	occasional
	White Fig	*Ficus virens*	occasional
Lower Stratum	Smilax	*Smilax australis*	common
	Common Ground Fern	*Calochlaena dubia*	common
	Harsh Ground Fern	*Hypolepis muelleri*	common
	Gristle Fern	*Blechnum cartilagineum*	occasional
	* Lantana	*Lantana camara*	occasional
	Native Ginger	*Alpinia caerulea*	occasional

* introduced species

2c Blackbutt *E pilularis*

Structure
Tall to very tall (15-30m) open forest; mid-stratum mid-dense; lower stratum dense.

Habitat and Distribution
Scattered through the survey area on ridges and northwest to northeast-facing slopes. Soils are shallow, yellow podzols formed on metasediment.

Condition
Generally only fair, as most stands are limited in extent, disturbed and have a significant weed component.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Blackbutt	*Eucalyptus pilularis*	common
	Broad-leaved Ironbark	*Eucalyptus siderophloia*	occasional
	* Camphor Laurel	*Cinnamomum camphora*	occasional
Mid-stratum	Sally Wattle	*Acacia melanoxylon*	common
	Tree Bitter Pea	*Daviesia arborea*	common
	Celerywood	*Polyscias elegans*	common
	Guioa	*Guioa semiglauca*	common
	Red Ash	*Alphitonia excelsa*	occasional
	Sweet Pittosporum	*Pittosporum undulatum*	occasional
	Bolwarra	*Eupomatia laurina*	occasional
	Scentless Rosewood	*Synoum glandulosum*	occasional
	Five-leaf Water Vine	*Cissus hypoglauca*	occasional
Lower Stratum	* Crofton Weed	*Ageratina adenophora*	common
	* Mist Flower	*Ageratina riparia*	common
	* Molasses Grass	*Melinis minutiflora*	common
	Mat Rush	*Lomandra longifolia*	common
	Common Ground Fern	*Calochlaena dubia*	common
	Barb Wire Vine	*Smilax australis*	common
	Gristle Fern	*Blechnum cartilagineum*	common
	Climbing Guinea Flower	*Hibbertia scandens*	common
	Blady Grass	*Imperata cylindrica*	common
	Running Postman	*Kennedia rubicunda*	occasional

* introduced species

2d Broad-leaved Ironbark *E siderophloia* - Tallow-wood *E microcorys* - Pink Bloodwood *C intermedia*

Structure
Very tall (20-30m) open forest; mid-stratum mid-dense; lower stratum dense.

Habitat and Distribution
This community occurs in Brunswick Heads NR, immediately northeast of the highway bridge around the carpark and on adjacent slopes. The soil is a shallow, red-yellow podzol formed on deeply weathered metasediments.

Condition
Fair to good, although the carpark area and adjacent slopes have been disturbed by quarrying. Much of the forest is fairly recent regeneration, probably 40 to 50 years old.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Broad-leaved Ironbark	*Eucalyptus siderophloia*	common
	Tallow-wood	*Eucalyptus microcorys*	common
	Pink Bloodwood	*Corymbia intermedia*	common
	* Camphor Laurel	*Cinnamomum camphora*	occasional
Mid-stratum	Brush Ironbark Wattle	*Acacia aulacocarpa*	common
	Broad-leaved Ballart	*Exocarpos latifolius*	common
	Common Silkpod Vine	*Parsonsia straminea*	common
	Guioa	*Guioa semiglauca*	common
	* Lantana	*Lantana camara*	common
	Cudgerie	*Flindersia schottiana*	occasional
	Sweet Pittosporum	*Pittosporum undulatum*	occasional
	Bolwarra	*Eupomatia laurina*	occasional
	Scentless Rosewood	*Synoum glandulosum*	occasional
	Sandfly Zieria	*Zieria smithii*	occasional
	Hovea	*Hovea acutifolia*	occasional
Lower Stratum	Ottochloa	*Ottochloa gracillima*	common
	Mat Rush	*Lomandra longifolia*	common
	Blue Flax Lily	*Dianella caerulea*	common
	Gristle Fern	*Blechnum cartilagineum*	common
	Barb Wire Vine	*Smilax australis*	common
	Blady Grass	*Imperata cylindrica*	common
	* Mist Flower	*Ageratina riparia*	common
	Common Ground Fern	*Calochlaena dubia*	common

* introduced species

VEGETATION UNIT 3 SWAMP SCLEROPHYLL FOREST

3a Broad-leaved Paperbark *Melaleuca quinquenervia*

Structure
Tall (12-18m) open forest; mid-stratum sparse to mid-dense; lower stratum dense.

Habitat and Distribution
This association occurs in three areas:

- south of the Brunswick River;
- opposite the Billinudgel turn off on the eastern side of the existing highway; and
- in the north of the study area in Billinudgel NR.

Stands occur in low-lying, seasonally inundated areas with little or no saline influence.

Condition
Good. Structurally mature and only minor weed-infestation.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Broad-leaved Paperbark	*Melaleuca quinquenervia*	common
	Swamp Mahogany	*Eucalyptus robusta*	occasional
	Swamp She-oak	*Casuarina glauca*	occasional
Mid-stratum	Common Silkpod Vine	*Parsonsia straminea*	common
	Umbrella Cheese Tree	*Glochidion sumatranum*	occasional
	Sally Wattle	*Acacia melanoxylon*	occasional
Lower Stratum	Bungwahl Fern	*Blechnum indicum*	common
	Harsh Ground Fern	*Hypolepis muelleri*	common
	Soft Twig Rush	*Baumea rubiginosa*	common
	Bunchy Sedge	*Cyperus lucidus*	common
	Cutting Sedge	*Gahnia clarkei*	common
	Swamp Rice Grass	*Leersia hexandra*	common
	* Five-leaf Morning Glory	*Ipomoea cairica*	common
	* Sour Grass	*Paspalum conjugatum*	common
	Ischaemum	*Ischaemum australe*	occasional

* introduced species

3b Swamp Mahogany *Eucalyptus robusta*

Structure
Tall (12-18m) open forest; mid-stratum sparse to mid-dense; lower stratum dense.

Habitat and Distribution
This community occurs on seasonally waterlogged peaty soils at slightly higher elevation than community 3a (Broad-leaved Paperbark). Two stands were identified within the study area:

- south of Billinudgel adjacent to the railway line; and
- northeast of Billinudgel, between Shara Boulevard and Marshall's Creek.

Condition
Good. Stands are structurally mature with only minor weed-infestation.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Swamp Mahogany	*Eucalyptus robusta*	common
	Broad-leaved Paperbark	*Melaleuca quinquenervia*	occasional
Mid-stratum	Sally Wattle	*Acacia melanoxylon*	occasional
	Umbrella Cheese Tree	*Glochidion sumatranum*	occasional
Lower Stratum	Bunchy Sedge	*Cyperus lucidus*	common
	Bungwahl Fern	*Blechnum indicum*	common
	Harsh Ground Fern	*Hypolepis muelleri*	common
	Soft Twig Rush	*Baumea rubiginosa*	common
	Cutting Sedge	*Gahnia clarkei*	common
	Swamp Rice Grass	*Leersia hexandra*	common
	* Groundsel Bush	*Baccharis halimifolia*	occasional

* introduced species

3c Swamp Oak *Casuarina glauca*

Structure
Mid-high to tall (12-20m) open forest and woodland; mid-stratum sparse; lower stratum dense.

Habitat
Occurs in low-lying areas subject to saline influence during spring high tides.

Condition
Good. Regrowth stands approaching maturity with light weed-infestation.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Swamp Oak	*Casuarina glauca*	common
	Swamp Turpentine	*Lophostemon suaveolens*	occasional
	Broad-leaved Paperbark	*Melaleuca quinquenervia*	occasional
Mid-stratum	Common Silkpod Vine	*Parsonsia straminea*	common
	Staghorn Fern	*Platycerium bifurcatum*	occasional
	Coastal Boobialla	*Myoporum acuminatum*	occasional
	* Broad-leaved Pepper Tree	*Schinus terebinthifolia*	occasional
	* Lantana	*Lantana camara*	occasional
Lower Stratum	Ottochloa	*Ottochloa gracillima*	common
	Ivy Leaf Violet	*Viola hederacea*	common
	* Water Buttons	*Cotula coronopifolia*	common
	Bare Twig Rush	*Baumea juncea*	common
	Swamp Lily	*Crinum pedunculatum*	occasional
	Swamp Barnyard Grass	*Echinochloa telmatophila*	occasional
	Mangrove Fern	*Acrostichum speciosum*	occasional
	Spiky Bog Rush	*Schoenus brevifolius*	occasional

* introduced species

VEGETATION UNIT 4 SEDGELAND

- Saw Sedge *Cyperus lucidus* - Articulated Rush *Baumea articulata*

Structure
Very tall (1-3m) closed sedgeland.

Habitat and Distribution
This community is located in the north of the study area, opposite Shara Boulevard on the western side of the highway. It occurs in a permanently wet depression infilled with peat, which is probably on a basement of Pleistocene sand overlying bedrock

Condition
Good. Minor weed-infestation around the margin.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Broad-leaved Paperbark	*Melaleuca quinquenervia*	occasional
	Sally Wattle	*Acacia melanoxylon*	occasional
Lower Stratum	Bunchy Sedge	*Cyperus lucidus*	common
	Articulated Rush	*Baumea articulata*	common
	Bungwal Fern	*Blechnum indicum*	common
	Harsh Ground Fern	*Hypolepis muelleri*	common
	Soft Twig Rush	*Baumea rubiginosa*	common
	Swamp Rice Grass	*Leersia hexandra*	common
	Common Reed	*Phragmites australis*	common
	Knotweed	*Persicaria strigosa*	common
	* Groundsel Bush	*Baccharis halimifolia*	occasional

* introduced species

VEGETATION UNIT 5 MANGROVES

- Grey Mangrove *Avicennia marina* var *australasica* - River Mangrove *Aegiceras corniculata*

Structure
Mid-high (6-12m) open woodland to open forest; mid-stratum absent, lower stratum absent or dense where Saltwater Couch (*Sporobolus virginicus* var *minor)* is present.

Habitat
Mudflats on the northern and southern side of the Brunswick River. Mangroves occupy the tidal zone between the average heights of low and high tide.

Condition
Good. Relatively undisturbed.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Grey Mangrove	*Avicennia marina* var *australasica*	common
	River Mangrove	*Aegiceras corniculatum*	common
	Swamp Oak	*Casuarina glauca*	occasional
Lower Stratum	Saltwater Couch	*Sporobolus virginicus* var *minor*	common
	Berry Saltbush	*Einadia hastata*	occasional

VEGETATION UNIT 6 SALTMARSH

- Saltwater Couch *Sporobolus virginicus* var *minor*

Structure
Low open to closed grassland.

Habitat
Tidal grassland occurring adjacent to mangroves on slightly higher ground. Saltmarsh occupies the tidal zone just above the height of average high tide.

Condition
Good. Undisturbed.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Grey Mangrove	*Avicennia marina* var *australasica*	occasional
Lower Stratum	Saltwater Couch	*Sporobolus virginicus* var *minor*	common
	Saltwater Rush	*Juncus krausii* subsp *australiensis*	common
	Bare Twig Rush	*Baumea juncea*	common
	Zig Zag Bog Rush	*Schoenus brevifolius*	occasional
	Eriochloa	*Eriochloa pseudoacrotricha*	occasional
	Saloop Saltbush	*Einadia hastata*	occasional

VEGETATION UNIT 7 DISTURBED FOREST REGROWTH/CLEARED

7a Sally Wattle *A melanoxylon* - Camphor Laurel *Cinnamomum camphora*

Structure
Mid-high woodland to open forest.

Habitat
This community is common in the study area, and occurs on any soil type or topographic position with the exception of seasonally inundated soils or tidal areas.

Condition
Disturbed regrowth occurs on land that was cleared and grazed, probably for several decades, then abandoned. Most stands appear to be 20-40 years old. Species diversity is generally low with limited colonisation of native plants, with the exception of a few pioneers such as Sally Wattle *Acacia melanoxylon*. Introduced species often dominate this community or make up a large proportion of the total number of species.

Condition
Good. Relatively undisturbed.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Grey Mangrove	*Avicennia marina* var *australasica*	common
	River Mangrove	*Aegiceras corniculatum*	common
	Swamp Oak	*Casuarina glauca*	occasional
Lower Stratum	Saltwater Couch	*Sporobolus virginicus* var *minor*	common
	Berry Saltbush	*Einadia hastata*	occasional

VEGETATION UNIT 6 SALTMARSH

- Saltwater Couch *Sporobolus virginicus* var *minor*

Structure
Low open to closed grassland.

Habitat
Tidal grassland occurring adjacent to mangroves on slightly higher ground. Saltmarsh occupies the tidal zone just above the height of average high tide.

Condition
Good. Undisturbed.

LAYER	COMMON NAME	BOTANICAL NAME	ABUNDANCE
Upper Stratum	Grey Mangrove	*Avicennia marina* var *australasica*	occasional
Lower Stratum	Saltwater Couch	*Sporobolus virginicus* var *minor*	common
	Saltwater Rush	*Juncus krausii* subsp *australiensis*	common
	Bare Twig Rush	*Baumea juncea*	common
	Zig Zag Bog Rush	*Schoenus brevifolius*	occasional
	Eriochloa	*Eriochloa pseudoacrotricha*	occasional
	Saloop Saltbush	*Einadia hastata*	occasional

VEGETATION UNIT 7 DISTURBED FOREST REGROWTH/CLEARED

7a Sally Wattle *A melanoxylon* - Camphor Laurel *Cinnamomum camphora*

Structure
Mid-high woodland to open forest.

Habitat
This community is common in the study area, and occurs on any soil type or topographic position with the exception of seasonally inundated soils or tidal areas.

Condition
Disturbed regrowth occurs on land that was cleared and grazed, probably for several decades, then abandoned. Most stands appear to be 20-40 years old. Species diversity is generally low with limited colonisation of native plants, with the exception of a few pioneers such as Sally Wattle *Acacia melanoxylon*. Introduced species often dominate this community or make up a large proportion of the total number of species.

Endangered Species

Species considered in this section include those listed under Schedule 1 of the TSC Act and Part 1 of the ESP Act (Table 4.4), unless otherwise stated.

- Davidson's Plum *Davidsonia pruriens* subsp *jerseyana*

Davidson's Plum is a slender tree to 10m in height which occurs in subtropical rainforest and Brush Box forest (Appendix 6). It generally occurs on red or yellow podzolic soils on metasedimentary parent materials, at altitudes less than 300m. This species is listed as Endangered under the TSC Act and ESP Act, and the subspecies *D pruriens* subsp *jerseyana* is endemic to the north coast of NSW, in the Brunswick and Tweed Valleys. Davidson's Plum also has a (national) ROTAP code of 2ECi (Table 4.4), which denotes a geographic range of less than 100km (Table 4.5).

During field surveys along and near Route A2, Davidson's Plum was recorded (a total of 45 individuals) in regrowth Brush Box forest and rainforest at three locations within the study area:

- on south-facing slopes between the Brunswick River and Banana Road;
- west of the Salad Bowl Caravan Park; and
- in regrowth forest alongside the railway line at the northern end of the study area.

Of these, approximately 25 are likely to be removed or disturbed by the proposal, particularly in the Smokey Valley (between the Brunswick River and Banana Road).

Additional individuals are present on the south-facing slopes beyond the A2 corridor, towards the edge of the swamp sclerophyll forest in Smokey Valley (near the sewage treatment plant).

Along Route A2, Davidson's Plum is associated with vegetation communities 1b - Subtropical rainforest on metasediment, 1c - Regrowth Subtropical Rainforest on metasediment and 2a - Brush Box Forest. Generally this species is rare in the lower Brunswick valley area, with a total population estimated at 1000-1500 plants. It is reserved in Brunswick Heads NR, Billinudgel NR and Inner Pocket NR (Briggs & Leigh 1996; Quinn *et al* 1995; WBM Oceanics 1996).

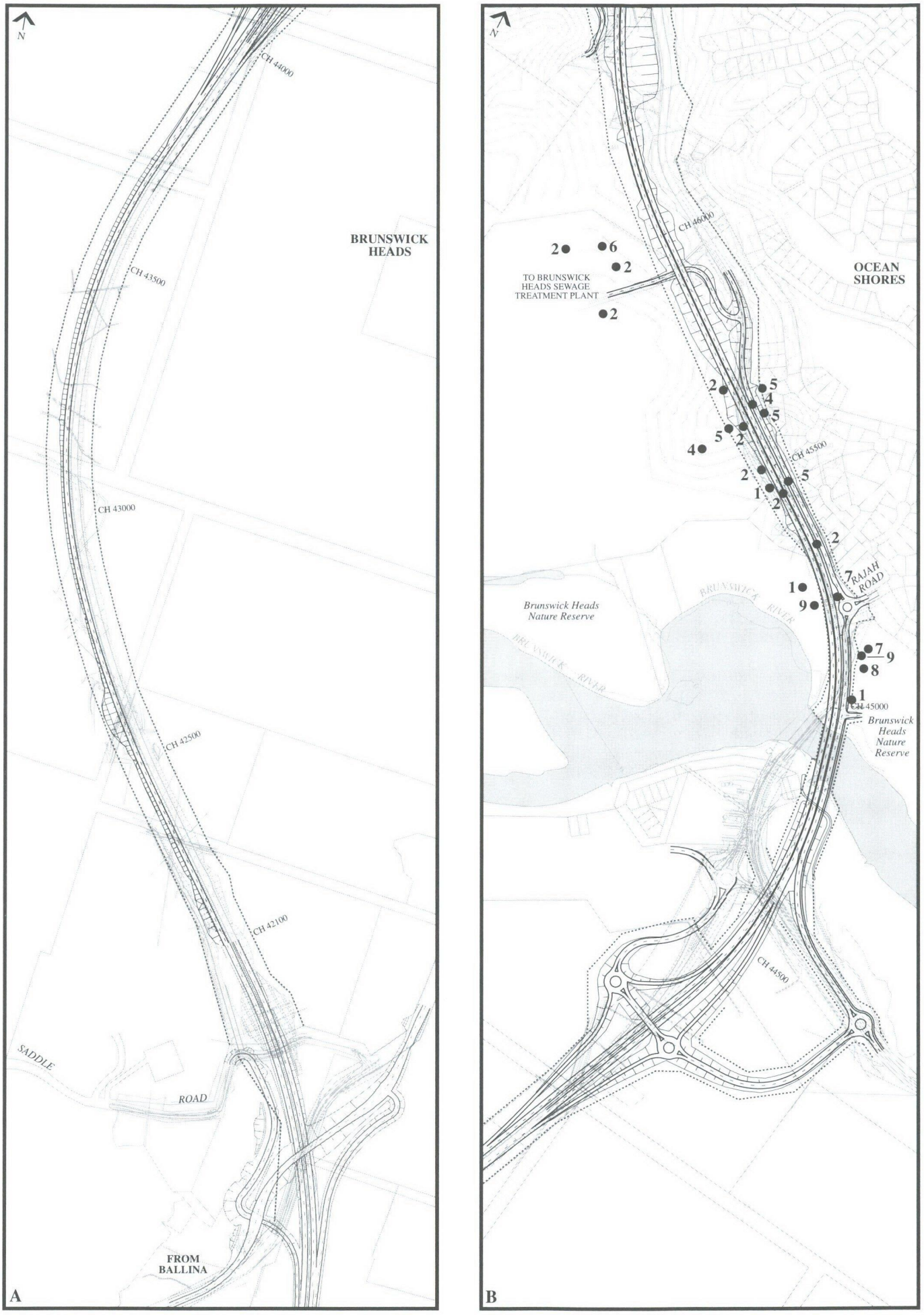
Extensive clearing of lowland subtropical rainforest for agriculture and grazing has had a deleterious impact on most populations of Davidson's Plum, and further clearing poses a threat to some populations that are located on private property (Quinn *et al* 1995). Many listed populations occur on minor roadside verges, and are potentially threatened by roadworks and other activities. Conversely, this species is readily propagated (Appendix 8), with 100% likelihood of germination.

- Hairy Quandong *Elaeocarpus williamsianus*

The Hairy Quandong is a small rainforest tree to 15m in height, which favours medium fertility soils formed on metasediments (Appendix 6). It occurs in Brush Box forest and rainforest communities, and along Route A2, the Hairy Quandong is associated with vegetation type 2a - Brush Box forest.

This species has a ROTAP code of 2ECi (Briggs & Leigh 1996, Table 4.5), and is listed as Endangered under the TSC Act. The Hairy Quandong is also listed on Part 1 of the Commonwealth ESP Act. The total known population of this species in NSW is probably less than 300 trees (J Hunter NP&WS *pers comm*), with just one population being reserved, in Inner Pocket NR (WBM Oceanics 1996; Briggs & Leigh 1996).

The Hairy Quandong is endemic to lowland forest in the Brunswick and Tweed Valleys, where it is known from a total of just 6 locations (Mill Road, Goonengerry; Banana Road, Ocean Shores; Inner Pocket NR; Upper Burringbar; Mooball State Forest; and Couchy Creek in the Tweed Valley).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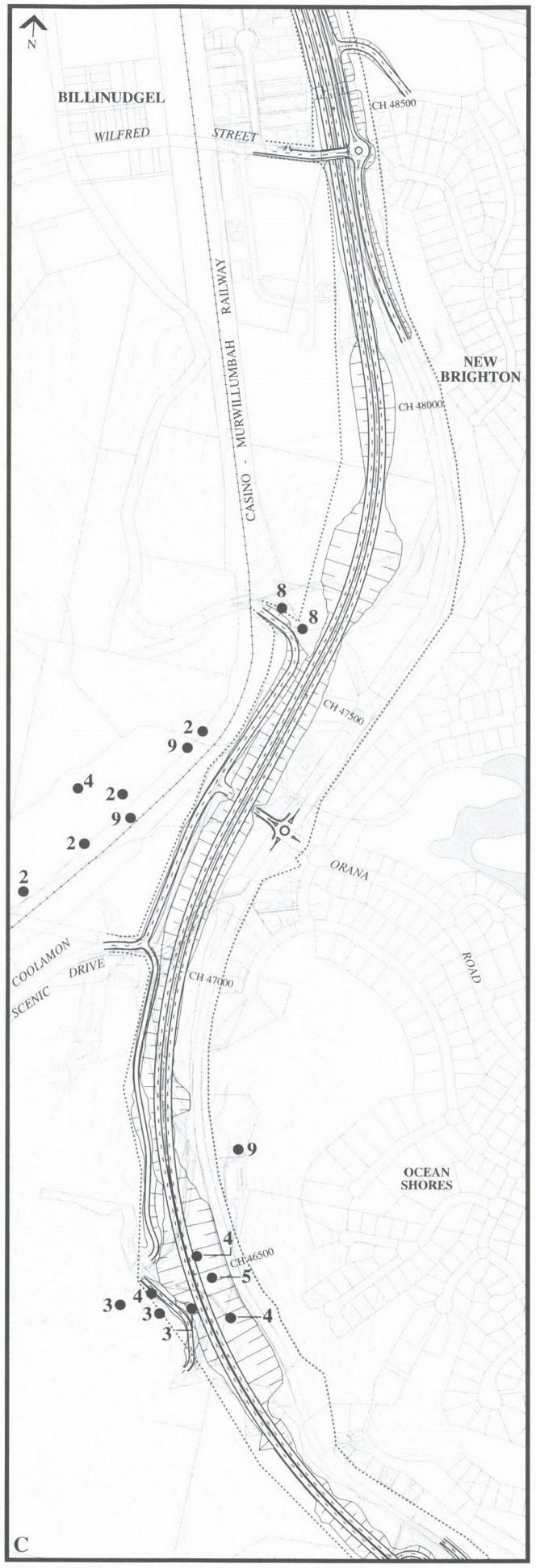
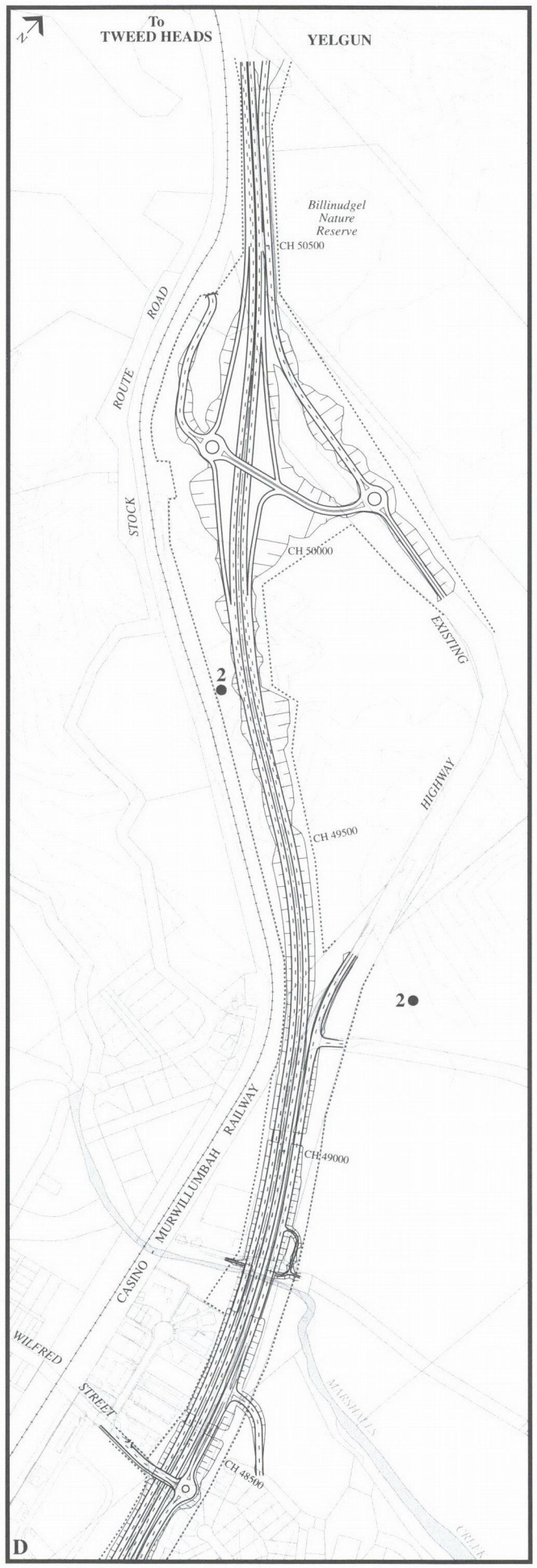
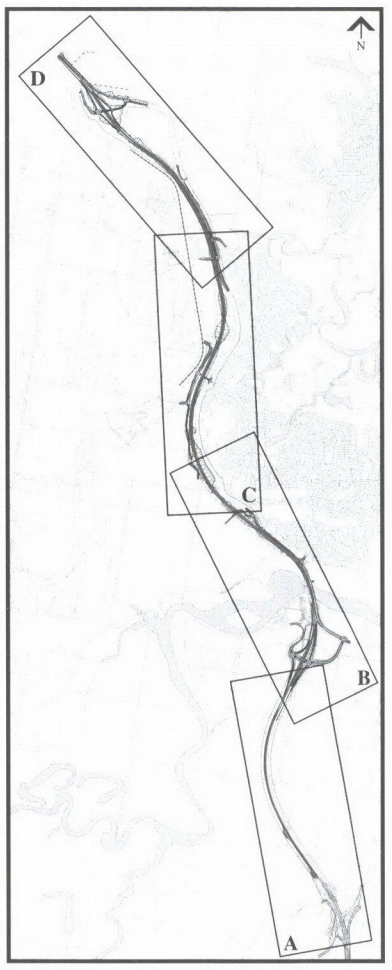






Legend

- 1● *Cryptocarya foetida* (Schedule 2)
- 2● *Davidsonia poriens ssp jerseyana* (Schedule 1)
- 3● *Elaeocarpus williamsianus* (Schedule 1)
- 4● *Endiandra floydii* (Schedule 1)
- 5● *Endiandra muelleri ssp braeteata* (Schedule 1)
- 6● *Macadamia tetraphylla* (Schedule 2)
- 7● *Randia moorei* (Schedule 1)
- 8● *Syzygium hodgkinsoniae* (Schedule 2)
- 9● *Syzygium moorei* (Schedule 2)
- ..... Proposed Road Corridor

Figure 9
LOCATION OF FLORA SPECIES OF CONSERVATION SIGNIFICANCE

Figure 9
LOCATION OF FLORA SPECIES OF CONSERVATION SIGNIFICANCE

A group of approximately 15 Hairy Quandongs occur below Banana Road in Brush Box forest on a lower slope near the edge of cleared land (Figure 9). The distance between Route A2 (including batters) and the population of Hairy Quandong is approximately 110m, and the roadworks will not affect this population. In addition, a single tree was located about 100m to the east and further upslope, approximately 50m from the A2 batter. Again, this specimen will not be affected, as there will not be any discharge from the roadworks into this area.

The major threats to the Hairy Quandong are fire, weed invasion and possible erosion. The main limitations to expanding the conserved population of this species is a lack of suitable habitat with secure tenure (NP&WS 1996), and the apparent infertility of seed and failure of plants to propagate vegetatively, although natural vegetative reproduction appears to occur in the wild state.

- Crystal Creek Walnut *Endiandra floydii*

This small rainforest tree is endemic to the Tweed and Brunswick Valleys (Harden 1990), where it occurs in rainforest on soils derived from metasediment, often on steep slopes (Appendix 6). In the lower Brunswick Valley, Crystal Creek Walnut occurs in Brush Box forest and rainforest from the mouth of the Brunswick River inland to Mt Chincogan near Mullumbimby.

Crystal Creek Walnut has a ROTAP code of 2VC- (Table 4.5) and is listed as Endangered under the TSC Act and the ESP Act. It is reserved in Brunswick Heads NR and possibly Numbinah NR in the Tweed Valley (WBM Oceanics 1996; A Benwell *pers obs*). The total population in the lower Brunswick Valley is estimated to be approximately between 300 and 500 mature trees.

Along Route A2, Crystal Creek Walnut was recorded in vegetation type 1c - Regrowth Subtropical rainforest on metasediment and 2a - Brush Box forest. The largest populations detected during the flora surveys for the A2 alignment were in Brunswick Heads NR and the Hilans Corner area. Crystal Creek Walnut was recorded in Brush Box forest and rainforest at four locations within the study area:

- on properties in Oola Place, backing onto the existing highway;
- in regrowth forest immediately west of Brunswick Heads NR;
- on steep slopes below Banana Road; and
- in rainforest west of the Salad Bowl Caravan Park.

A total of five mature trees and two juveniles were recorded on or very close to Route A2 and its batters at the Oola Place properties and on steep slopes on Banana Road. Plants immediately west of Brunswick Heads NR were approximately 100 metres from Route A2, and those to the west of the Salad Bowl Caravan Park are also well outside Route A2.

Crystal Creek Walnut is readily propagated (Appendix 8), with the likelihood of successful germination being 100%.

- Green-leaved Rose Walnut *Endiandra muelleri* subsp *bracteata*

The Green-leaved Rose Walnut grows to 30m in height and occurs in lowland Brush Box forest or rainforest on medium fertility soils or metasediment (Appendix 6). It is listed as Endangered under the TSC Act, but is not listed on the ESP Act.

The distribution of Green-leaved Rose Walnut is poorly known, partly because of confusion with its identification. It is found north from Maclean in NSW, but occurs mainly on the eastern margin of the Mount Warning shield. In the Brunswick and Tweed valleys, it is probably widespread but uncommon, favouring coastal areas. It has recently been recorded in Mooball State Forest and is probably reserved in Brunswick Heads NR (Benwell *pers obs*). It is also reserved in Maclean Reserve (WBM Oceanics 1996).

Along Route A2, Green-leaved Rose Walnut was recorded in vegetation type 1c - regrowth rainforest on metasediment and 2a - Brush Box forest, at four locations:

- on properties in Oola Place backing onto the existing highway;
- on south-facing slopes between the Brunswick River and the sewage treatment plant;
- on slopes below Banana Road; and
- along Old Stock Route Road near Billinudgel.

A total of 13 adult trees and several juveniles were recorded at the above locations, of which 10 will be removed or are likely to be affected by the proposal. However, other individuals were recorded in the study area.

The Green-leaved Rose Walnut is readily propagated, with an 80% likelihood of successful germination from seed (Appendix 8).

- Spiny Gardenia *Randia moorei*

A shrub or small tree, reaching 10m in height, Spiny Gardenia occurs in subtropical, riverine and littoral rainforest on a range of substrates, including deep alluvial, basalt and slate derived soils (Appendix 6). It is recorded from the Lismore area north to the Logan River in southern Queensland (Quinn *et al* 1995). A total of 23 locations are listed for the species in NSW and eight in Queensland.

Spiny Gardenia has a ROTAP code of 3ECi (Table 4.4 and Table 4.5), and is listed as Endangered under both the TSC Act and the ESP Act. It is reserved in Brunswick Heads, Broken Head and Stotts Island NRs (Floyd 1989; Briggs & Leigh 1996: WBM Oceanics 1996). Threatening processes for Spiny Gardenia include the clearing of its original habitat (Barry & Thomas 1994). Some of the reserved NSW populations, such as those in Wilsons Park, are at risk due to small population sizes and degradation of remaining habitat by weeds.

Along Route A2, Spiny Gardenia is associated with vegetation type 1a - subtropical rainforest on alluvium and 1b - subtropical rainforest on metasediment. During the field surveys, this species was recorded at three locations within the study area, including:

- in Brunswick Heads NR, west of the existing highway in the alluvial rainforest margin;
- in Brunswick Heads NR, east of the existing highway; and
- in the Hilans Corner area.

Two individual Spiny Gardenias were recorded along Route A2, in that portion of the Brunswick Heads NR west of the highway (immediately north of the Brunswick River). The two individuals are located in the rainforest margin, immediately adjacent to the proposed road corridor, with other individuals present elsewhere in this portion of rainforest. Whether the two individuals adjacent to the alignment can be retained is presently uncertain, but a range of measures are to be implemented to ensure either their *in situ* conservation (if possible), or their retention in the general vicinity and possible use in rehabilitation of the rainforest margins. A number of other individuals were recorded in the Brunswick Heads NR to the east of the existing highway, but outside of the proposed road corridor.

Spiny Gardenia is readily propagated, with an 80% likelihood of successful germination from seed (Appendix 8).

Vulnerable Species Schedule 2 of the TSC Act and Part 2 of the ESP Act

Species considered in this section include those listed under Schedule 2 of the TSC Act and Part 2 of the ESP Act (Table 4.4), unless otherwise stated.

- Stinking Cryptocarya *Cryptocarya foetida*

A small to medium-sized rainforest tree, Stinking Cryptocarya occurs in littoral rainforest on old sand dunes, and in subtropical rainforest over slate and occasionally basalt-derived soils, at altitudes below 150m (Appendix 6). Stinking Cryptocarya has a ROTAP code of 3VCi (Briggs & Leigh 1996, Table 4.5), and is listed as Vulnerable under the TSC Act and Endangered under the ESP Act.

Quinn *et al* (1995) lists a total of 39 locations for the species in NSW and 7 in Queensland. Stinking Cryptocarya occurs in littoral rainforest remnants from the Ballina area north to the Queensland border, and the species extends inland to a few areas such as Mooball SF and Inner Pocket NR, where it tends to be very rare.
Populations are reserved in Brunswick Heads NR, Broken Head NR, Tyagarah NR and Ukerabagh NR. Along Route A2, Stinking Cryptocarya is associated with vegetation type 1a - subtropical rainforest on alluvium, 1b - subtropical rainforest on metasediment and 1c - regrowth subtropical rainforest on metasediment.

During the field surveys conducted for this project, Stinking Cryptocarya was recorded at three locations in the study area:

- west of the existing highway within Brunswick Heads NR;
- east of the existing highway within Brunswick Heads NR; and
- on south-facing slopes between Brunswick Heads NR and the sewage treatment plant.

Of these, 13 individuals are likely to be affected by the proposal, both in the Brunswick Heads NR and south of Banana Road.

Much of the original habitat of this species has been destroyed through clearing for urban development and previous sand-mining, and clearing for residential development in the sublittoral zone remains a key threat. Weed invasion of the smaller habitat remnants is also a potential long-term threat to some populations.

Little information is available regarding this species' susceptibility and response to disturbance, although it appears that it does not recruit in areas that have been subjected to intensive sand-mining in the Kingscliff-Cudgen area (Quinn *et al* 1995).

Moderate success in germination of seed of Stinking Cryptocarya (60%) can be expected, although trees apparently do not set fruit every year, and the amount of seed available will vary on an annual basis (Appendix 8).

- Queensland Nut *Macadamia tetraphylla*

A small to medium tree to 15m in height and often multi-trunked close to the base. It occurs in low elevation subtropical rainforest and Brush Box forest (Appendix 6).

Queensland Nut has a ROTAP code of 2VC- (Table 4.4 and Table 4.5) and is listed as Vulnerable under the TSC Act and as Endangered under the Commonwealth ESP Act. It is reserved in Nightcap NP, Davis Scrub NR, Mt Warning NP, Numbinah NR, Victoria Park NR and Limpinwood NR (Briggs & Leigh 1996; WBM Oceanics 1996). Populations of this species at any given location tend to be very small (P Pisanu *pers comm*), usually with no more than 20 individuals.

Queensland Nut is endemic to the eastern margin of the Mount Warning shield, between Rous near Lismore and Mount Tamborine in Queensland. Intergrades between this species and *M integrifolia* have been found near Beechmont, in the Tambourine Mountain area and north to Wangawallen Creek, where both species co-exist (Quinn *et al* 1995). Along Route A2, Queensland Nut is associated with vegetation type 1c - regrowth subtropical rainforest on metasediment.

During the field surveys for this project, a single individual was recorded on the western side of the sewage treatment plant access road in regrowth rainforest. This adult tree was

estimated to be approximately 120m from Route A2, and therefore will not be affected by the proposal.

- Coolamon Tree *Syzygium moorei*

A medium-sized to large tree, Coolamon Tree is found in lowland subtropical rainforest in the Richmond, Brunswick and Tweed valleys on the eastern margin of the Mount Warning shield (Appendix 6). Along Route A2, the Coolamon Tree is associated with vegetation type 1a- Subtropical rainforest on alluvium, 1b - Subtropical rainforest on metasediment, 2a - Brush Box forest and 7a - disturbed forest (regrowth/cleared).

Coolamon Tree has a ROTAP code of 2VCi (Table 4.4 and Table 4.5) and is listed as Vulnerable under the TSC Act and as Endangered under the Commonwealth ESP Act. It is reserved in Brunswick Heads, Numbinah, Hayters Hill and Stotts Island NRs (Briggs & Leigh 1996; WBM Oceanics 1996). Habitat clearing and fragmentation, and degradation of riverine rainforests are the main threats to this species (Sheringham & Westaway 1995).

The Coolamon Tree was recorded at three locations within the study area:

- west of the existing highway within Brunswick Heads NR;
- east of the existing highway within Brunswick Heads NR; and
- in rainforest west of the Salad Bowl Caravan Park.

All plants recorded were located outside the proposed road corridor.

- Red Lilly Pilly *Syzygium hodgkinsoniae*

A small rainforest tree, Red Lilly Pilly occurs on basalt soils, alluvium and metasediment-derived soils in Brush Box forest and rainforest up to an altitude of about 500m (Appendix 6).

Red Lilly Pilly has a ROTAP code of 3VC (Table 4.4 and Table 4.5) and is listed as Vulnerable under the TSC Act and as Endangered under the Commonwealth ESP Act. Red Lilly Pilly is reserved in Brunswick Heads, Inner Pocket, Boatharbour, Davis Scrub, Numinbah, Hayters Hill, Limpinwood, Snows Gully and Johnstons Scrub NRs; Big Scrub and Minyon Falls FRs; and Mt Warning and Nightcap NPs (Briggs & Leigh 1996).

Red Lilly Pilly is distributed from the Richmond River to Kin Kin in southeast Queensland. This species was recorded at three locations within the study area:

- west of the existing highway within Brunswick Heads NR;
- east of the existing highway within Brunswick Heads NR; and
- along Old Stock Route Road.

Two individuals (one adult and one juvenile) were recorded along Route A2 (near Old Stock Route Road), whilst plants recorded at the other sites were located outside the proposed road corridor. Along Route A2, Red Lilly Pilly is associated with vegetation communities 1b - Subtropical rainforest on metasediment and 2a - Brush Box forest.

Comprehensive population data are not available for the species, but at least 1000 plants are estimated to occur in Nullum and Mooball SF (*unpublished data* Comprehensive Regional Assessment).

Red Lilly Pilly can readily be propagated, with a 90% likelihood of successful germination (Appendix 8). Seed is generally available from wild plants, although seedlings can be difficult to establish as a consequence of Red Bud Mite. This observation will require addressing should this species be used for propagation along the proposal.

ROTAP Species - Briggs & Leigh 1996

A total of twelve ROTAP species (Briggs & Leigh 1996) were recorded along Route A2. Of these, eight species have already been discussed (above) as threatened species under the TSC Act (Section 4.2.2). The four additional ROTAP species recorded during the field surveys along Route A2 (Table 4.4), are Marblewood *Acacia bakeri*, Black Walnut *Endiandra globosa*, Veiny Laceflower *Archidendron muellerianum* and Long-leaved Tuckeroo *Cupaniopsis newmanii*.

Table 4.5 Conservation status codes for ROTAP - Rare Or Threatened Australian Plants (Briggs & Leigh 1996).

Distribution Category	
1	Known by only one collection only.
2	Species with a geographic range of less than 100km.
3	Species with a geographic range of greater than 100km.
Conservation Status	
X	**Presumed extinct**: not collected or otherwise verified over the past 50 years.
E	**Endangered**: taxon in serious risk of disappearing from the wild within 10-20 years if present land use and other threats continue to operate.
V	**Vulnerable**: not currently endangered; at risk of disappearing from the wild state within 20-50 years.
R	**Rare**: but not currently endangered or vulnerable.
K	**Poorly Known**: taxon that is suspected, but not definitely known, to belong to one of the above categories. At present, accurate field distribution information is inadequate.
C	**Reserved**: has at least one population within a National Park, Conservation Reserve, or area dedicated for the protection of flora.
Size-class of all Reserved Populations	
a	1000 plants or more are known to occur within a conservation reserve(s).
i	less than 1000 plants are known to occur within a conserved reserve(s).
-	reserved population size is not accurately known.
t	total known population reserved;
+	Overseas occurrence (included if the taxon has a natural occurrence overseas).

- Marblewood *Acacia bakeri*

A medium-sized to large tree, Marblewood occurs in wet sclerophyll forest and rainforest. Marblewood is distributed from the Brunswick Valley north to Maryborough in Queensland (Williams *et al* 1984), but in NSW is restricted to the eastern margin of the Mt Warning caldera. This species often occurs in the ecotone between rainforest and wet sclerophyll forest on metasediments enriched with basaltic colluvium.

Populations of Marblewood in NSW include the Hilans Corner area (30-40 plants), Brunswick Heads NR (500+), Billinudgel NR (10-20), Black Scrub Flora Reserve in Nullum SF (50-100), Mooball SF (20-30) and the Cudgen area (*unpublished data* Comprehensive Regional Assessment).

At least 50 individuals were recorded at locations within Brunswick Heads NR outside the proposed road corridor. A total of eleven plants were recorded along Route A2 (and are likely to be affected by the proposal) at three locations:

- west of the existing highway within Brunswick Heads NR;
- east of the existing highway within Brunswick Heads NR; and
- in regrowth forest between the Brunswick Heads NR and the sewage treatment plant access road.

- Black Walnut *Endiandra globosa*

Black Walnut is a small rainforest tree endemic to the eastern Mt Warning district between the Brunswick valley and the Gold Coast hinterland. This species is relatively common in the study area, in mature and regrowth stands of wet sclerophyll forest and rainforest.

Black Walnut occurs in wet sclerophyll forest and rainforest on metasedimentary geology and more rarely on rhyolite (*eg* Mt Jerusalem NP) and sedimentary rocks. It is locally common in the Brunswick Valley, the northern half of Nullum SF and into the Tweed Valley. Black Walnut is common in the Burringbar Range, including Mooball SF and occurs in the Tallebudgera and Currumbin Creek Valleys in Queensland.

Black Walnut is reserved in Inner Pocket, Brunswick Heads, Numbinah and Billinudgel NRs, Nightcap NP and Nullum SF (Floyd 1989). Approximately 30 individuals of Black Walnut were recorded during the flora survey for the project on or very close to Route A2, with roughly equal numbers of mature specimens and juveniles being located. Black Walnut was recorded at the following locations in the study area:

- on the eastern side of the existing highway, within Brunswick Heads NR;
- on properties in Oola Place, backing onto the existing highway;
- on south-facing slopes below Banana Rd; and
- along Old Stock Route Road near Billinudgel.

At least 200 trees were estimated to occur in the study area outside the proposed road corridor.

- Veiny Laceflower *Archidendron muellerianum*

A small to medium-sized tree, Veiny Laceflower occurs in lowland subtropical rainforest and wet sclerophyll forest between Rous near Lismore and Mudgeeraba (Queensland), with an outlier on the Richmond Range west of Casino. This species is found in suitable habitat throughout the Brunswick Valley, the Burringbar Range, the eastern half of the Tweed Valley and the Big Scrub district. It is reserved in the Border Ranges and Mt Warning NPs, Whian Whian and Mooball Sfs, and Victoria Park, Hayters Hill, Broken Head, Inner Pocket, Numbinah and Limpinwood NRs (Briggs & Leigh 1996; Floyd 1989).

Six individuals (1-2 metres high) were recorded in Brush Box forest along Route A2 in the Banana Road area. Several other specimens were recorded on the eastern side of the highway within Brunswick Heads NR and outside the proposed road corridor, including one tree about 18m high, an exceptional size for this species.

- Long-leaved Tuckeroo *Cupaniopsis newmanii*

Long-leaved Tuckeroo is a small rainforest tree endemic to the eastern margin of the Mt Warning shield. Long-leaved Tuckeroo occurs between Mullumbimby and Mt Tamborine in wet sclerophyll forest and rainforest on metasediments, and less commonly on rhyolite and sedimentary geology.

Long-leaved Tuckeroo is widespread in the Brunswick Valley, Burringbar Range and Tweed Valley, and is relatively common in Mooball SF and the northern half of Nullum SF (Benwell 1997d). This species is reserved in Limpinwood, Inner Pocket, Brunswick Heads and Billinudgel NRs, and in Border Ranges and Mt Warning NPs.

Long-leaved Tuckeroo was recorded at three locations in the study area:

- on the eastern side of the existing highway within Brunswick Heads NR;
- between Brunswick Heads NR and the sewage treatment plant; and
- in the Banana Road area.

Seven individuals were recorded at the first two locations on or close to Route A2, and at least thirty plants were observed areas outside the proposed road corridor.

Plant Species of Regional Conservation Significance

A total of eleven plant species of regional conservation significance were recorded on or close to Route A2. The regional conservation significance of plant species recorded was assessed with reference to DeVries (1997). None of these species are protected under current State or Commonwealth legislation, but they are generally considered of conservation value because they are regionally or locally uncommon or rare. The presence of these species have been considered both during the route selection process and in considering the potential or likely impacts of the proposal.

Several additional species listed by Sheringham & Westaway (1995) were also recorded along the Bypass duplication study area, although these species are not regarded as of concern at the State or National level, nor are they listed by DeVries (1997) as of regional significance. Furthermore, none of the additional species listed by Sheringham & Westaway (1995) are likely to be restricted to the area proposed for the Bypass duplication.

- Mangrove Fern *Acrostichum speciosum*

Mangrove Fern is a large ground fern occurring on the edge of mangroves and reaching its southern limit at Iluka on the Clarence River (Harden 1990), south of Brunswick Heads.

A few plants were recorded near the Brunswick River bridge on Route A2. This species is locally common along the inland edge of mangrove communities in the Brunswick River and Marshall's Creek estuaries, and extends as far upstream as Mullumbimby and Billinudgel.

- Coelospermum *Coelospermum paniculatum*

A low-growing vine of coastal forests occurring north from the Clarence River (Harden 1990), this species is sparsely distributed on rainforest margins or in wet sclerophyll forest on sand or sandy alluvium in the lower Brunswick Valley area. A few individuals of Coelospermum were recorded on the edge of the Brunswick Heads NR, on the western side of the highway and within the proposed road corridor.

This species was also recorded during the route selection survey further up the Brunswick River (away from Route A2), and the plant also occurs in the Marshall's Creek area near Billinudgel (ECOS 1997), and in other parts of Brunswick Heads NR.

- Eumundi Quandong *Elaeocarpus eumundi*

A tall rainforest tree, Eumundi Quandong generally occurs north from the Nightcap Range into Queensland. In NSW, this species appears to occur mainly in the Nightcap Range, and is known from very few lowland locations.

Several specimens of Eumundi Quandong were recorded in rainforest west of the Salad Bowl Caravan Park, including some large trees. These specimens are well outside the proposed road corridor, and would not be affected.

- White Bark *Endiandra compressa*

A small to medium-sized rainforest tree, White Bark is generally found north from Minyon Falls Flora reserve (Nightcap Range). This species is rare in NSW, but is more common in Queensland. One tree was recorded in rainforest west of the Salad Bowl Caravan Park outside the proposed road corridor.

- White Yiel Yiel *Grevillea hilliana*

White Yiel Yiel is a medium-sized tree occurring north from the Brunswick River, and is listed as rare in NSW (DeVries 1997). This species is known from Brunswick Heads NR, Ocean Shores, Cudgen and locations in the Terranora and Lower Tweed River area.

Substantial populations appear to exist only in Brunswick Heads NR and in the lower Tweed area (A Murray *pers comm*).

Three small trees (between 1.5 and 4 metres high) were recorded along Route A2, on the western side of the existing highway, in alluvial rainforest at the Brunswick River bridge. These individuals were growing in the rainforest margin on the edge of Brunswick Heads NR. At least twenty trees were also recorded outside the proposed road corridor on the western and eastern sides of the existing highway in Brunswick Heads NR.

- Medicosma *Medicosma cunninghamii*

A shrub or small tree occurring north from the Richmond River, this species is regarded as rare in NSW, and as regionally significant by DeVries (1997). A single individual of Medicosma was recorded in regrowth rainforest west of the sewage treatment plant access road, well outside the proposed road corridor.

- Northern Euodia *Melicope vitiflora*

Northern Euodia is a small rainforest tree occurring in littoral rainforest and adjacent areas of sub-tropical rainforest north from Broken Head (Harden 1991). It is listed as rare in NSW by DeVries (1997).

A few trees of this species were recorded outside the proposed road corridor in Brunswick Heads NR, east of the existing highway, and in rainforest west of the Salad Bowl Caravan Park.

- Blush Coondoo *Planchonella laurifolia*

A large rainforest tree occurring north from Brunswick Heads (Harden 1990), Blush Coondoo has a sporadic distribution north of Brunswick Heads in NSW, occurring in remnant rainforest stands on metasediment. A relatively large population occurs in Mooball SF (Benwell 1997d).

This species was recorded in the study area at three locations:

- in Brunswick Heads NR east of the existing highway;
- on southerly slopes between the Brunswick Heads NR and the sewage treatment plant access road; and
- in rainforest west of the Salad Bowl Caravan Park.

A total of forty-two Blush Coondoo were recorded along Route A2 in the Brunswick Heads NR east of the highway. A further eleven plants were recorded between the Nature Reserve and the sewage treatment plant access road turn-off. Specimens recorded generally comprised juveniles and saplings, with a few specimens reaching small tree dimensions outside the proposed road corridor, particularly in Brunswick Heads NR, where the species is relatively common.

- Thin-leaved Coondoo *Planchonella chartacea*

A small rainforest tree occurring north from Byron Bay, Thin-leaved Coondoo grows in riverine areas and littoral rainforest (Harden 1990).

This species was recorded in the study area at three locations :

- in Brunswick Heads NR east of the existing highway;
- on properties in Oola Place backing onto the highway; and
- along the Old Stock Route Road near Billinudgel.

Six individuals were recorded on or very close to Route A2, including five mature trees and

one juvenile. Other individuals of Thin-leaved Coondoo were located in the Brunswick Heads NR outside the proposed road corridor, and the species is relatively common in this Reserve.

- Polyalthia *Polyalthia nitidissima*

Polyalthia is a small littoral rainforest tree occurring north from Iluka. Two trees of this species were recorded along Route A2 between the Brunswick Heads NR and the sewage treatment plant access road. This species is present in Brunswick Heads NR (Williams & Harden 1984) and in SEPP 26 littoral rainforest along Marshall's Creek.

- Xylosma *Xylosma terrae-reginae*

Xylosma is a small rainforest tree occurring north from Broken Head, which is listed as rare in NSW (DeVries 1997). A single sapling of this species was recorded along Route A2 between the Brunswick Heads NR and the sewage treatment plant access road. This species is conserved in Brunswick Heads NR (Williams & Harden 1984) and in Broken Head NR (A Floyd *pers comm*).

4.3.3 Conservation Significance of Vegetation Communities

To assess the regional conservation status of vegetation communities through the study area, the vegetation communities have been correlated with vegetation types recognised in broad classification systems for the region (Table 4.6).

With respect to assessing the conservation status of the rainforest types occurring in the study area, it is necessary to refer to Floyd (1990), whose classification and conservation assessments have been largely adopted by Hager & Benson (1994). In addition, the conservation status of rainforest communities in the study area are assessed with reference to a more recent assessment of conservation adequacy by the Department of Environment & Heritage (1995).

For assessing the open forest communities in the study area, the State Forests system of Forest Types was used (FCNSW 1989), with subsequent translation of these communities into their equivalents under the classification of Hager & Benson (1994) for northeastern NSW (Section 4.2.3). This latter classification system attempts to assess the extent to which different communities are conserved in the state reserve system.

Table 4.6 Conservation status of vegetation communities located within the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

COMMUNITY	CONSERVATION STATUS
Vegetation Unit 1: Rainforest	
1a Subtropical Rainforest on alluvium Suballiance 3: *Cryptocarya obovata-Dendrocnide excelsa-Ficus* spp-*Araucaria cunninghamia* (Floyd 1990)	RF102 - *Cryptocarya obovata Dendrocnide excelsa Ficus* spp-*Araucaria* is coded A (adequately conserved) by Hager & Benson (1994). Floyd (1990) also states that suballiance 3 is adequately conserved in NSW.
1b Subtropical Rainforest on metasediment Suballiance 5/21: *Castanospermum australe-Dysoxylum muelleri/Araucaria cunninghamii* (Floyd 1990)	RF 104 - *Castanospermum australe Dysoxylum muelleri* is coded A (adequately conserved) by Hager & Benson (1994). Floyd (1990) also states that suballiance 5 is adequately conserved. RF 200 - *Araucaria cunninghamii* is coded A (adequately conserved) by Hager & Benson (1994). Floyd (1990) states that suballiance 21 is adequately conserved.
1c Regrowth subtropical rainforest on metasediment Suballiance 5/21: *Castanospermum australe-Dysoxylum muelleri/Araucaria cunninghamii*(Floyd 1990)	RF 104 - *Castanospermum australe-Dysoxylum muelleri* is coded A (adequately conserved) by Hager & Benson (1994). Floyd (1990) also states that suballiance 5 is adequately conserved. RF 200 - *Araucaria cunninghamii* is coded A (adequately conserved) by Hager & Benson (1994). Floyd (1990) states that suballiance 21 is adequately conserved.

Table 4.6 contd Conservation status of vegetation communities located within the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

COMMUNITY	CONSERVATION STATUS
1d Gallery dry rainforest Suballiance17/21: *Cupaniopsis anacardioides/Araucaria cunninghamii* (Floyd 1990)	RF 116 - *Cupaniopsis anacardioides* is coded E (excellently conserved), where all major areas are conserved (Benson & Hager 1994). Floyd (1990) states that suballiance 17 is adequately conserved. As noted by Griffith (1993), this association is also well conserved in SEPP 26 - Litteral Rainforest Stands. RF 200 - *Araucaria cunninghamii* is coded A (adequately conserved) by Hager & Benson (1994). Floyd (1990) also states that suballiance 21 *Araucaria* spp is adequately conserved.
1e Regrowth dry rainforest on basalt Suballiance 21: *Araucaria cunninghamii* (Floyd 1990)	RF 200 - *Araucaria cunninghamii* is coded A (adequately conserved) by (Hager & Benson 1994). Floyd (1990) also states that suballiance 21 *Aracauria* spp is adequately conserved.
Vegetation Unit 2: Wet Sclerophyll Forest	
2a Brush Box *Lophostemon confertus*	Forest Type 53 - Brush Box (FCNSW 1989); EF 101 - Between 10% and 25% conserved. Rated 3 (inadequately conserved), because major parts of the geographic range remain poorly protected (Hager & Benson 1994). "*Nonetheless, designated stands outside of reserves are protected under SEPP 26*" (Griffith 1993).
2b Forest Red Gum *Eucalyptus tereticornis*	Forest Type 92 - Forest Red Gum (FCNSW 1989); EF 111 - Between 5% and 10% conserved. Rated 3 (inadequately conserved), because major parts of its geographic range remain poorly protected (Hager & Benson 1994). Rated as "*poorly reserced over much of its range*" by Griffiths (1993).
2c Blackbutt *Eucalyptus pilularis*	Forest Type 37 - Dry Blackbutt (FCNSW 1989); EF 115 - Between 10% and 25% conserved. Rated 3 (inadequately conserved), because major parts of the geographic range remain poorly protected (Hager & Benson 1994).
2d Broad-leaved Ironbark *E siderophloia*-Tallow-wood *E microcorys*-Pink Bloodwood *C intermedia*	Forest Type - 62 variant (FCNSW 1989) EF 118 Between 5% and 10% conserved. Rated 3 (inadequately conserved), because major parts of the geographic range remain poorly protected (Hager & Benson 1994).
Vegetation Unit 3: Swamp Sclerophyll Forest	
3a Paperbark *Melaleuca quinquenervia*	Forest Type 31 - Paperbark (FCNSW 1989); WT 101- Between 10% and 25% conserved. Rated 3 (inadequately conserved), because major parts of its geographic range remain poorly protected, despite moderate areas being located in reserves (Hager & Benson 1994). "*widespread on the North & Central Coasts*" (Griffith 1993).
3b Swamp Mahogany *Eucalyptus robusta*	Forest Type 30 - Swamp Mahogany (FCNSW 1989); EF 202 - Between <10% and <25% conserved. Rated 3 (inadequately conserved) (Hager & Benson 1994), despite levels of conservation. Regarded as well reserved over parts of its range, "*south of the Evans River, but not so elsewhere*", including in the study area (Griffith 1993).
3c Swamp She-oak *Casuarina glauca*	Forest Type 32 - Swamp Oak (FCNSW 1989); WT 101 - Rated 4 (undetermined), because additional information on the size of an adequate sample is required (Hager & Benson 1994). Conversely, "*many stands are designated under SEPP 14 - Coastal Wetlands*" (Griffith 1993).
Vegetation Unit 4: Sedgeland	
Saw Sedge *Cyperus lucidus* - Articulated Rush *Baumea articulata*	Not considered by Hager & Benson (1994).
Vegetation Unit 5: Mangroves	
Grey Mangrove *Avicennia marina* - River Mangrove *Aegiceras corniculata*	Forest Type 33 (FCNSW 1989) WT 303 - Between 5% and 10% is conserved. Rated 3 (inadequately conserved), because major parts of its geographic range remain poorly protected, despite moderate areas being located in reserves (Hager & Benson 1994). "*Only limited areas .. are reserved*", although SEPp 14 protects many stands (Griffith 1993).
Vegetation Unit 6: Saltmarsh	
Saltwater Couch (*Sporobolus virginicus*)	*S virginicus* is the most widespread saltmarsh grass in Australia (Adam 1981), and is adequately conserved. Poorly reserved, although often protected under SEPP 14 (Griffith 1993).

VEGETATION UNIT 1 RAINFOREST

1a Subtropical Rainforest on Alluvium (Benwell 1997d; Williams & Harden 1984).

This vegetation community in the study area is equivalent to suballiance 3: *Cryptocarya obovata - Dendrocnide excelsa - Ficus spp - Araucaria* (Floyd 1990). This community is restricted to a small area of floodplain on the western side of the existing highway, within Brunswick Heads NR, and consists of mature rainforest with little evidence of disturbance or weed invasion, except along the road edge.

Conservation status
This suballiance is restricted to floodplain alluvium in northern NSW, a habitat which has been almost totally cleared for agriculture. Remnant stands are reserved in Stotts Island NR, Boatharbour NR, Johnstons Scrub NR, Bellingen Island Reserve, Wingham Brush NR and Coocumbac Island NR.

Floyd (1990) considers that suballiance 3 is adequately conserved in NSW. However, more recent assessments of conservation adequacy requiring that 10-15% of the pre-settlement distribution of ecosystems be reserved (Department of Environment & Heritage 1995), would conclude that this community is well below adequate reservation.

Ib Subtropical Rainforest on Metasediment (Benwell 1997d; Williams & Harden 1984).

This vegetation community in the study area is equivalent to suballiances 5/21: *Castanospermum australe - Dysoxylum muelleri/ Araucaria cunninghamii* (Floyd 1990, and to Subtropical Rainforest on Upland Slate and Phyllite Areas (Williams & Harden 1984).

It occurs on sheltered, southeast to southwest-facing slopes on metasedimentary geology at two locations:

- west of the Salad Bowl Caravan Park and railway line; and
- on the eastern side of the existing highway in Brunswick Heads NR.

The condition of this rainforest community is good, with no weed invasion or other signs of disturbance except on the forest margin.

Conservation status
The lowland subtropical rainforest occurring on metasediments in the Brunswick-Tweed district, which extends into southeastern Queensland, fits poorly into the rainforest classification of Floyd (1990). This is freely acknowledged by Floyd and other rainforest ecologists (J Hunter *pers comm* 1998). The mixed suballiance 5/21 roughly fits the floristic and ecological characteristics of lowland metasediment rainforest in the far northeast of NSW, but would be better classified in its own suballiance.

Examples of suballiance 5 are reserved in Numinbah NR, Johnstons Scrub NR, David Scrub NR, Inner Pocket NR, Border Ranges NP and elsewhere. Suballiance 21 is reserved in many Nature Reserves and Flora Reserves through the McPherson Range, and in the lower Nymboida-Chandlers Creek area south of Grafton.

Floyd (1990) considered that suballiances 5 and 21 are adequately conserved in NSW. However, more recent assessments of conservation adequacy, requiring that 10-15% of the pre-settlement distribution of ecosystems be reserved (Department of Environment & Heritage 1995) would conclude that this community is well below adequate reservation.

1c Regrowth Subtropical Rainforest (Benwell 1997d; Floyd 1990).

This community occurs on protected, east to south-facing slopes at two locations:

- between the existing highway and the sewage treatment plant; and
- on footslopes and the floodplain near the Salad Bowl Caravan Park on both sides of the railway line.

The condition of this community varies from good to poor depending on the degree of structural development, species diversity and weed infestation. Stands in the study area probably represent 30-50 years of regrowth, and appear to occur on sites where rainforest was cleared and disturbed without eliminating all original rainforest plants or their seedbanks.

Conservation status
This rainforest community is equivalent to community 1b above, but in a regrowth condition. The same comments regarding conservation status of community 1b therefore apply to this community.

1d Gallery Rainforest (Benwell 1997d; Williams & Harden 1984).

This vegetation community in the study area is equivalent to suballiance 21: *Araucaria* and suballiance 17: *Cupaniopsis anacardioides* (Floyd 1990), and to Littoral Rainforest on Sand (Williams & Harden 1984). It is found on alluvium overlying sand on natural levees on either side of Marshall's Creek. This community is a remnant, reduced to a narrow strip along Marshall's Creek, surrounded by cleared land and development. Weed infestation is moderately high due to factors such as edge effects, but otherwise the condition of this community is fair.

Suballiance 17 is the most widespread suballiance of littoral rainforest on the NSW north coast. Along the Tweed coastline, only small pockets remain (due to rutile mining), and at Fingal, a small section of dune shields this alliance from saline influences. Other small remnants are found at Hastings Point, Lower Cudgera and from Potts Point to New Brighton (Floyd 1990).

Suballiance 21 is reserved in Limpinwood NR on steep rhyolite slopes and it also occurs in Mebbin SF along Bog Onion and Forty Spur Roads on mudstones and coal below basalt (Floyd 1990).

Within the Big Scrub area that originally extended from Lismore to Byron Bay, there are only three remnants of Suballiance 21 surviving. Within the city of Lismore, 19.3ha of rainforest remains in Wilson Park and 10.5ha in Rotary Park. The third remnant of suballiance 21 within the Big Scrub area occurs at Hayters Hill (Floyd 1990).

Conservation status
Floyd (1990) observed that stands of suballiance 17 and 21 are both adequately conserved. Nearby conserved areas of suballiance 17 include Brunswick Heads NR, Broken Head NR and Bundjalung NP (Floyd 1990).

1e Regrowth Dry Rainforest on Basalt (Benwell 1997d).

This vegetation community in the study area is equivalent to suballiance 21: *Araucaria cunninghamii* (Floyd 1990). This community occurs on an upper, south-facing slope at the top of a cutting on the Ocean Shores hill and on an exposed, east-facing slope adjoining the public utilities area on the same hill.

The condition of this community is poor, and the stand next to the utilities area has also been heavily disturbed by past clearing. The stands are in an early stage of regrowth and have moderate to high levels of weed infestation and a reduced species diversity, but retain a distinctive dry rainforest composition.

Conservation status
Examples of suballiance 21 are reserved in many Nature Reserves and Flora Reserves through the McPherson Ranges, and the lower Nymboida - Chandlers Creek area, south of Grafton. Floyd (1990) considered that suballiance 21 is adequately conserved in NSW. However, more recent assessments of conservation adequacy requiring that 10-15% of the pre-settlement distribution of ecosystems be reserved (Department of Environment & Heritage 1995), would conclude that this community is below adequate reservation.

5 FAUNA

5.1 BRUNSWICK HEADS BYPASS DUPLICATION

5.1.1 Fauna Habitats

The fauna habitats along the Brunswick Heads Bypass duplication portion of the project are already highly disturbed and modified as a result of previous clearing and agricultural practices, and as a consequence of the construction of the existing single carriageway Brunswick Heads Bypass. Given that the proposed duplication will involve the construction of a second two-lane carriage immediately to the west of the existing Bypass (disturbing only a few hectares of already modified and widely distributed vegetation - see Table 6.1), and given the nature and condition of the landscape in which the Bypass is located, none of the habitats or resources present in this locality are regarded as of particular significance in conservation terms to native fauna.

The Brunswick Heads Bypass is located in disturbed woodland and open forest communities and in areas of agricultural land. As a consequence, the main habitats for native fauna which are present include areas of woodland and open forest (generally with a relatively sparse understorey), pasture and grassland, and several small creeklines. As noted above, previous and existing disturbance along the route of the Brunswick Heads Bypass has affected the woodland and forest habitats for fauna in this locality, and these habitats are not characterised by resources or habitat features (such as hollow-bearing trees, hollow logs or dense understorey vegetation) which are of particular relevance or significance for native fauna.

The small creeklines which cross the Brunswick Heads Bypass are also modified as a result of previous agricultural activities, and have been affected by the existing Brunswick Heads Bypass construction. Nevertheless, these features provide some resources for native fauna, particularly for some common amphibian species, occasional wetland birds and species which rely on denser riparian vegetation. In two cases, tidal influences extend up the creeklines almost to the Bypass, but no mangrove or estuarine habitats will be affected to any significant degree by the proposed Bypass duplication.

A substantial portion of the Brunswick Heads Bypass traverses pasture and grassland communities, which are generally of relatively little relevance for native fauna species, except those which are tolerant of disturbed habitats or which are widely distributed and wide-ranging. The pasture and grassland areas along the Bypass are not of particular concern as fauna habitats in this locality, given their artificial nature and their local and regional extent.

As noted above, the habitats and resources available for native fauna which will be affected by the proposed Brunswick Heads Bypass duplication are already modified and disturbed from their original condition, both by existing and previous agricultural practices and clearing, and as a result of the construction of the existing Brunswick Heads Bypass. Whilst the area to be affected does support some resources and habitat features for native fauna species (trees, understorey vegetation, small creeklines, some forest litter *etc*), the resources or habitat elements present are not considered of particular relevance or significance for the conservation of any native fauna species.

5.1.2 Fauna Species Recorded

A list of fauna species was compiled during the field surveys in the study area for the proposed Brunswick Heads Bypass duplication, supplemented by records from previous investigations in the immediate vicinity and surrounding area and from the NP&WS Wildlife Atlas and Birds Australia (RAOU) database (Appendix 4). With regard to the NP&WS Atlas records, only those species recorded within approximately 10km of the existing alignment were considered relevant for discussion.

A total of 65 native vertebrate fauna species were recorded during the fauna surveys conducted within the proposed Bypass duplication study area, including 40 birds, 10 mammals (including 2 megachiropteran and 2 microchiropteran bats), 3 reptiles and 12 amphibians (Appendix 4). A number of additional fauna species which have been recorded

in the general area during previous investigations (Appendix 4), particularly that of Milledge & McKinley (1992), could also potentially occur in the immediate vicinity of the proposed duplication. However, the survey area of Milledge & McKinley (1992) was substantially larger than that for the proposed duplication, and many species (*eg* coastal waterbirds) would not be expected in the area to be affected by the duplication (given the absence of preferred habitat types) and others are not tolerant of disturbance.

Four threatened fauna species (TSC Act) were recorded during the fauna investigations, although one of the microchiropteran bats was only tentatively identified. A range of additional species of conservation concern previously recorded in the general area could potentially occur in the vicinity of the Bypass duplication, at least on occasion (Appendix 4), including species recorded by Milledge & McKinley (1992) such as the Eastern Grass Owl and Long-nosed Potoroo. Conversely, neither of these species is considered likely to occur in the disturbed and modified habitats immediately adjacent to the existing Brunswick Heads Bypass. Threatened species recorded in the study area are discussed in detail in Sections 5.1.3 and 5.2.3, with additional species known to occur in the surrounding area considered in Section 5.3.

Birds

Forty native bird species (comprising 25 passerine and 15 non-passerine species) were recorded during the fauna investigations (Appendix 4), the majority of which are common to abundant and widespread in distribution. The bird species recorded were predominantly forest and woodland species or those tolerant of some habitat modification and which are typical of semi-natural environments.

Passerine birds include all species of the diverse order Passeriformes, which are known as 'song birds' or 'perching birds'. These species were representative of a variety of guilds, including insectivores (*eg* thornbills, scrubwrens and fairy-wrens), forest pollinators (*eg* honeyeaters), ground feeders (*eg* the Emerald Dove), and predators and scavengers (*eg* the Pied Currawong, Pied and Grey Butcherbirds).

Non-passerine bird species include mostly large terrestrial and aquatic birds, which lack singing voices. Non-passerine species recorded during the field investigations in the study area and in adjacent habitats, include a range of waterbirds, waders, parrots and cockatoos, pigeons and doves, and the Kookaburra.

The majority of the bird species recorded in the study area are typically associated with forest and woodland habitats. All of the species recorded are common and widespread in suitable habitat in coastal NSW, including the Kookaburra, Fan-tailed Cuckoo, Eastern Whipbird, Peaceful Dove, Spangled Drongo, Pheasant Coucal and Grey Fantail. No threatened woodland and forest bird species were recorded along the proposed duplication alignment or in the vicinity during the fauna investigation, although a number are known from the general area (and are discussed further in Section 5.3).

Waterbird species typically associated with wetland, riverine and riparian habitats were not common in the study area, given the general absence of suitable habitat. Only the Pacific Black Duck and the Great Cormorant were recorded during the fauna survey.

Other bird species recorded in the study area are typically associated with the open agricultural lands which are characteristic of the surrounding landscape. Whilst generally relying on woodland and forest habitats for nesting and shelter, these species also utilise semi-natural environments (such as pasture and road verges) for foraging. Species recorded in these habitats along the proposed alignment include the Eastern Rosella, Willie Wagtail, Galah, Australian Magpie and Welcome Swallow.

A large number of additional bird species, including a number of threatened species, have been recorded in the general area during previous investigations (Appendix 4). Whilst some of these species could potentially occur along the duplication alignment (at least on occasion), others will not be present due to an absence of specific resources. The only additional threatened bird species recorded in the general vicinity (*ie* within 1km of the Bypass) is the Eastern Grass Owl (Milledge & McKinley 1992). This species is not considered likely to occur in those areas immediately adjacent to the existing Bypass which are to be

affected by the proposed duplication. Additional threatened bird species known from the surrounding area are discussed further in Section 5.3 of this report.

Mammals

Ten native and two introduced mammal species were recorded during field surveys in the proposed Bypass duplication study area (Appendix 4). A further thirty-one mammal species have been recorded in the surrounding area (Appendix 4), some of which may also potentially occur in areas of suitable habitat along the proposed duplication alignment. Small mammal trapping revealed the presence of one native species (the Bush Rat) and one introduced species (the House Mouse). A number of other widespread and common small mammal species, including the Fawn-footed Melomys, Grassland Melomys, Brown Antechinus and Swamp Rat, have also been recorded in the general vicinity (Appendix 4), and may occur in areas of suitable habitat in the general vicinity.

The Northern Brown Bandicoot was identified in the study area during spotlighting surveys and the Long-nosed Bandicoot is also known to occur in the immediate vicinity. Two macropod species (the Swamp Wallaby and Red-necked Wallaby) were also recorded during spotlighting surveys and diurnal habitat searches in forest and woodland communities in the study area. The Swamp Wallaby is regarded as "*common*" within its range in Australia (Marchant 1995), whilst the Red-necked Wallaby is regarded as "*common to abundant in most parts of its range*" (Calaby 1995).

The previous investigations in the locality recorded the Long-nosed Potoroo near the Brunswick Heads Bypass (Milledge & McKinley 1992). This species occurs in areas with a dense understorey, including heathland vegetation, and is typically not tolerant of highly modified areas or sites characterised by ongoing disturbance. Notwithstanding the previous record of this species in the vicinity of the existing Brunswick Heads Bypass, it was not recorded during the spotlighting, trapping or hair-tube sampling for the Bypass duplication, and is not considered likely to be affected by the proposal.

Two arboreal mammal species (the Ringtail Possum and the Squirrel Glider) were recorded during fauna surveys in the study area. Both species rely on forest and woodland communities for their foraging and shelter requirements. The Squirrel Glider is listed as a Vulnerable species under Schedule 2 of the TSC Act, whilst the Ringtail Possum is regarded as widespread and common to abundant throughout its range (McKay & Ong 1995). The Squirrel Glider is discussed further in Section 5.1.3.

A number of other arboreal mammal species (such as the Koala, Mountain Brushtail Possum, Sugar Glider and Feathertail Glider) have been recorded in the general area during previous investigations (Appendix 4), and could also potentially occur in areas of suitable habitat in the general vicinity. The Koala is listed as a Vulnerable species under Schedule 2 of the TSC Act, and is discussed further in Section 5.2.3.

A range of bat species were recorded in the study area, including two megachiropteran and two microchiropteran bat species. The Queensland Blossom Bat was recorded in woodland communities near the southern end of the proposed duplication alignment. This species is considered Vulnerable in NSW and is discussed further in Section 5.1.3. The Grey-headed Flying Fox was also recorded during nocturnal surveys along the proposed alignment.

Two microchiropteran bat species were recorded in the study area during the fauna investigations, through call recording and harp trapping activities (Appendix 5). Both the Eastern Long-eared Bat and the Greater Broad-nosed Bat are listed as Vulnerable species under the TSC Act, and are considered further in Section 5.1.3.

A further twelve microchiropteran bat species have been recorded in the general area during previous investigations. The majority of these species are hollow-roosting species, including the Eastern Freetail Bat, Chocolate Wattled Bat, Gould's Wattled Bat, Lesser Long-eared Bat and Eastern Forest Bat. The remainder, including the Little Bent-wing Bat and the Large-footed Myotis (both Vulnerable species), roost in caves or similar artificial structures (such as tunnels and mines). No suitable roosting caves or features for cave-dwelling bats are present along the proposed alignment.

Mammal species of conservation significance recorded during the field investigations in the study area are discussed in Section 5.1.3 of this report. Additional mammal species of conservation concern which have been recorded in the general area (Appendix 4), are considered further in Section 5.3.

Reptiles

Only three reptile species (the Common Tree Snake, Eastern Water Dragon and Garden Skink) were recorded during the field investigations in the study area for the proposed Bypass duplication, all of which have widespread distributions in eastern NSW and are common to abundant in status (Cogger 1992).

The Common Tree Snake is a diurnal species found in a wide range of coastal habitats in eastern NSW. This species forages in trees and shrubs and on the ground, and roosts in tree-hollows, under rocks or in crevices and caves. The Eastern Water Dragon is a semi-aquatic arboreal species which is most commonly observed perched on low branches over creeks and rivers. The Garden Skink inhabits leaf-litter, grass and rockpiles in wet and dry sclerophyll forest and coastal heaths, and is one of the most abundant species in suburban gardens in eastern NSW (Cogger 1992).

Thirty-one additional reptile species have been recorded during previous fauna investigations in the surrounding area, including a variety of skinks and snakes, as well as legless lizards, blind snakes and dragons (Appendix 4). The majority of these reptiles are widespread and abundant throughout a variety of habitats in eastern NSW and could also potentially occur in areas of suitable habitat in the vicinity of the proposed duplication alignment.

No threatened reptile species were recorded during the field investigations within the proposed Bypass duplication study area, nor have any been recorded during previous fauna investigations in the immediate vicinity and general surrounding area (Appendix 4).

Amphibians

Heavy rainfall immediately prior to the commencement of the fauna surveys provided ideal conditions for amphibian surveys, with individuals of a variety of species being both highly active and vocal. A total of twelve amphibian species (including one introduced species) were recorded during field investigations within the study area for the proposed Bypass duplication, through direct capture or using call identification (Appendix 4).

Many of the species recorded (including Freycinet's Frog, the Ornate Burrowing Frog and the Eastern Sign-bearing Frog) were recorded along the northern end of the proposed Bypass where there were large temporary pools of surface water during the fauna surveys. Other species (including the Eastern Dwarf Frog, Brown Frog and Spotted Grass Frog) were recorded in vegetation associated with small creeks, swamps and farm dams. Of the amphibian species recorded, the most common and widespread species was the introduced Cane Toad, which was detected widely through all habitats in the general study area.

A further thirteen amphibian species have been recorded in the surrounding area during previous investigations (Appendix 4), many of which could also potentially occur in areas of suitable habitat in the general vicinity of the proposed duplication alignment, at least on occasions.

Five amphibian species of conservation concern (Table 5.3), are known to occur in the region, although none have been recorded in the vicinity during previous investigations (*eg* Milledge & McKinley 1992). None of these species were detected during the current field investigations despite targeted surveys in areas of potentially suitable habitat (see Appendix 2).

5.1.3 Fauna Species of Conservation Significance

In New South Wales, threatened fauna species are defined as those listed on Schedules 1 (Endangered) and 2 (Vulnerable) of the TSC Act. Threatened species include those which are

considered of conservation concern because of restricted distributions or habitat requirements, significant population or distributional range declines, and where threats to species' survival still prevail.

Four threatened fauna species were recorded during investigations in the proposed Brunswick Heads Bypass duplication study area, including one tentative identification (Table 5.1; Appendix 5; Figure 10). All of the threatened fauna species recorded are dependent in one form or another on forest and woodland communities. The species recorded and their specific habitat requirements are discussed briefly below, with detailed species profiles provided in Appendix 7. The potential impacts on these fauna species as a result of the proposed Bypass duplication are discussed in Section 6. A detailed assessment of the significance of potential impacts on the threatened fauna recorded along the proposed alignment, under Section 5A of the NSW EP&A Act, is provided in Appendix 9.

An array of additional threatened fauna species are known from the surrounding area, some of which may also occur in the general vicinity of the study area on occasion. The relevance of these species to the proposed Bypass duplication is discussed further in Section 5.3.

Table 5.1 Locations of threatened fauna species recorded during field surveys in the study area for the proposed Brunswick Heads Bypass duplication (Figure 10).

STUDY AREA & SPECIES	STATUS	LOCATION	GRID REFERENCE	DETECTION METHOD
Squirrel Glider	V	Bypass alignment	6841200 552250	spotlight surveys
Queensland Blossom Bat	V	Harp trap No.1	6841600 553400	Harp trap
Eastern Long-eared Bat	V	Harp trap No.1	6841600 553400	Harp trap
Greater Broad-nosed Bat?	V	Northern forest block	6842500 552450	Anabat II recorder

? tentative call identification
V Vulnerable Species (TSC Act)

Non-flying Mammals

- Squirrel Glider

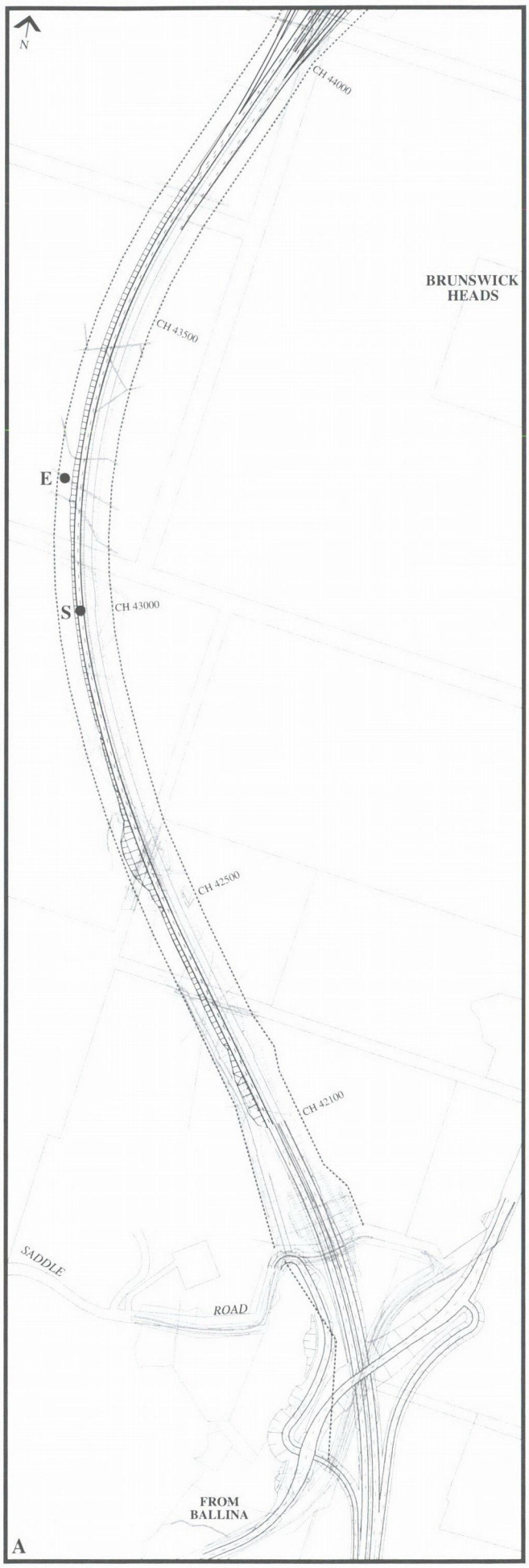
The Squirrel Glider *Petaurus norfolkensis* inhabits multi-aged dry sclerophyll forest and woodland in eastern Australia (Suckling 1995), particularly communities containing a variety of eucalypt species, including some smooth-barked and high-nectar producing species (Menkhorst *et al* 1988). Its diet consists of *Acacia* gum, *Eucalyptus* sap, invertebrates and insect exudates (such as lerps). Family groups require medium-sized tree-hollows for diurnal shelter and nesting and occupy home ranges of approximately 20 to 30ha.

The Squirrel Glider was recorded in dry sclerophyll forest on the eastern side of the existing Bypass alignment during the field surveys conducted for this investigation, but not in similar communities along the proposed Bypass duplication to the west. Whilst it is likely to utilise woodland and forest west of the Bypass, the Squirrel Glider is not likely to be dependent on resources adjacent to the Bypass.

Megachiropteran Bats

- Queensland Blossom Bat

The Queensland Blossom Bat *Syconycteris australis* occurs along the east coast of Australia, from Cape York to approximately Newcastle (Law & Spencer 1995). This species is a "*specialist blossom-feeder*" in the southern part of its range (Law & Spencer 1995), foraging on pollen and nectar from a wide variety of forest, woodland and heathland trees, including *Banksia*, *Eucalypt*, *Melaleuca* and *Callistemon* species. In tropical areas, *Syzygium* species also form a valuable dietary component (Law & Spencer 1995). In the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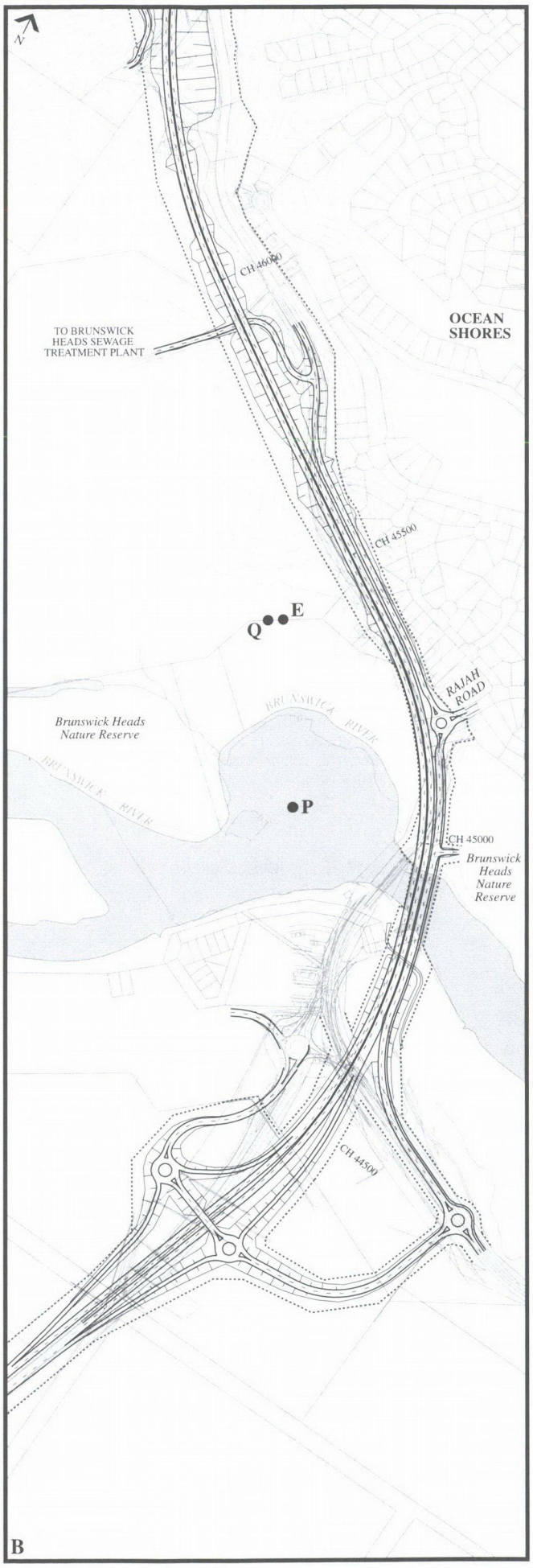
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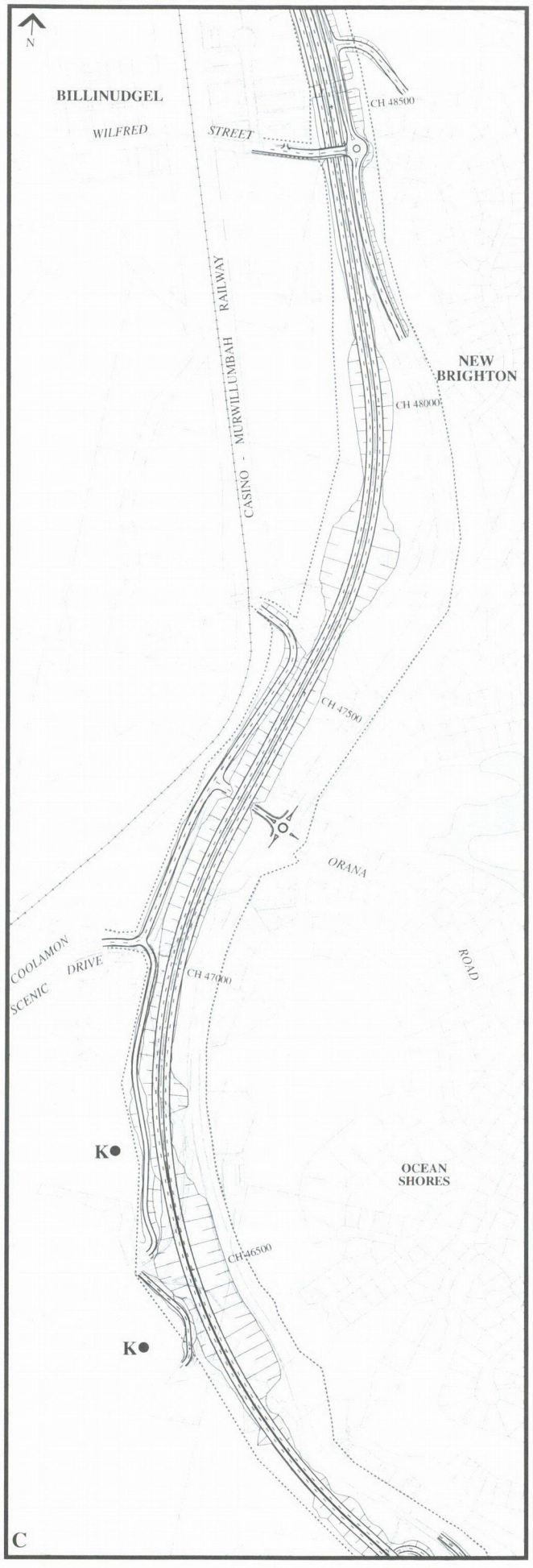

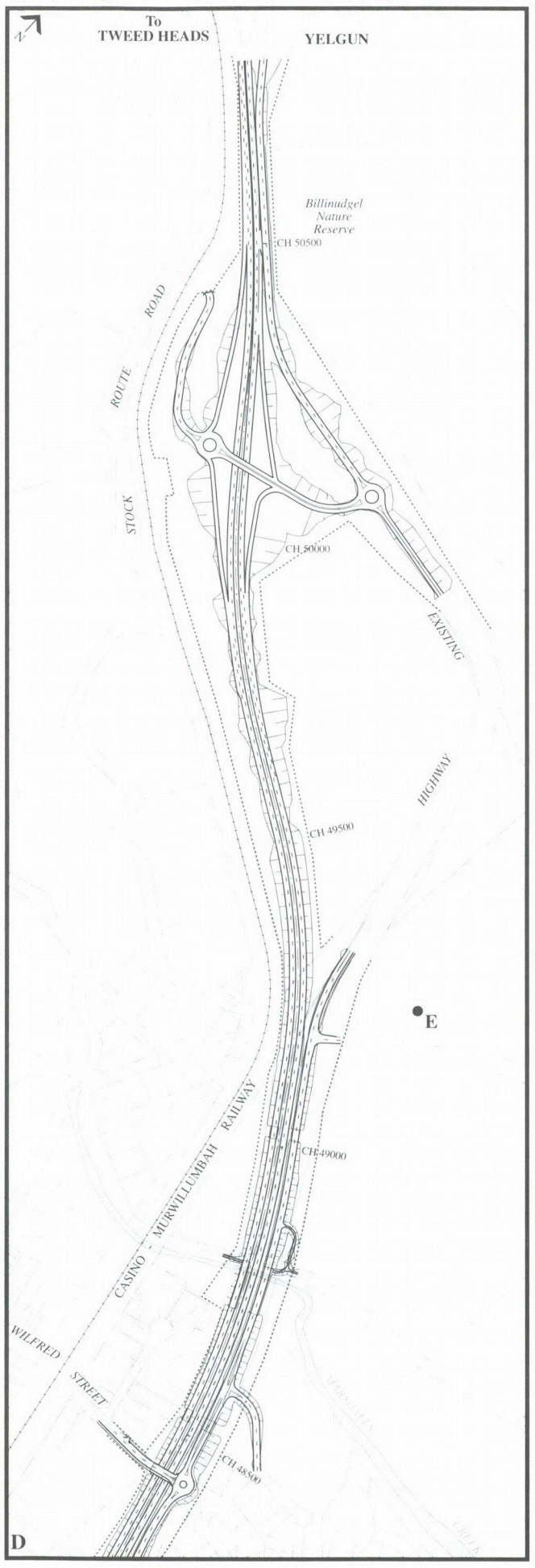

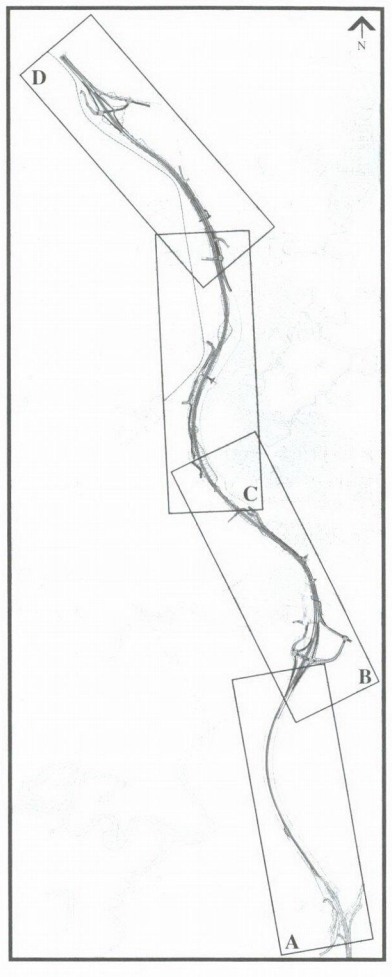

Legend

E	Eastern Long-eared Bat *Nyctophilus bifax*
Q	Queensland Blossum Bat *Syconycteris australis*
P	Pied Oystercatcher
S	Squirrel Glider
K	Koala
.....	Proposed Road Corridor

0 100 500m

Figure 10
LOCATION OF FAUNA SPECIES OF CONVERSATION SIGNIFICANCE

Figure 10
LOCATION OF FAUNA SPECIES OF CONVERSATION SIGNIFICANCE

northern portion of its range, Queensland Blossom Bats are facultative frugivores and to a lesser extent folivores (Law & Spencer 1995).

Important habitats for this species include rainforest or moist forest which provide roosting sites, adjacent to woodland or heathland communities which provide foraging resources (Law & Spencer 1995).

The Queensland Blossom Bat was recorded during harp trapping surveys in dry sclerophyll forest along the proposed Bypass alignment. This highly mobile species has been recorded previously in the general vicinity (NP&WS Atlas; Milledge & McKinley 1992), and is likely to forage widely throughout extensive areas of forest, woodland and shrubland communities in the surrounding area.

Microchiropteran Bats

- Eastern Long-eared Bat

The Eastern Long-eared Bat *Nyctophilus bifax* is locally common in habitats ranging from rainforest to riparian woodland. This species roosts communally in tree-hollows or amongst dense foliage) and shows seasonal changes in roost selection, favouring the edge of rainforest remnants in summer, and the centre of rainforest patches in winter (Parnaby 1995).

The Eastern Long-eared Bat was recorded in dry sclerophyll forest adjacent to paperbark forest during harp trap surveys conducted along the proposed Bypass duplication alignment. This species was also recorded during surveys for the proposed upgrade, Brunswick to Yelgun, immediately north of the Bypass duplication study area, and during other previous surveys in the general vicinity (Milledge & McKinley 1992; NP&WS database), and is likely to occur widely throughout suitable habitats in the surrounding area.

- Greater Broad-nosed Bat

The possible calls of the Greater Broad-nosed Bat *Scoteanax rueppellii* were recorded using an Anabat II ultrasonic call detector during field investigations in paperbark forest communities along the northern portion of the proposed Bypass duplication alignment. This species is likely to be present throughout the general area given its known distribution and on the basis of previous records (Milledge & McKinley 1992; NP&WS Wildlife Atlas).

The Greater Broad-nosed Bat occurs in eastern Australia, from southeast Queensland to northeastern Victoria. Its stronghold is in the gullies and river systems east of the Great Dividing range, but its distribution extends to the coast over much of its range (Hoye & Richards 1995). It is sparse but widely distributed along the north coast of NSW (Gilmore & Parnaby 1994).

The Greater Broad-nosed Bat occurs in a variety of habitats from woodland through moist and dry eucalypt forest to rainforest, foraging at a height of 3-6 metres in natural and artificial clearings in the vegetation and along creeks and small rivers. This species preys on slow-flying insects, and has been reported to kill and consume other bats in captivity (Gilmore & Parnaby 1994). Tree-hollows are generally utilised for maternity sites and for roosting, although it has also been found roosting in the roof spaces of old buildings (Hoye & Richards 1995).

5.2 BRUNSWICK to YELGUN UPGRADE

5.2.1 Fauna Habitats

In contrast to the Bypass duplication, the Brunswick to Yelgun section of the proposed upgrade project supports a wide array of habitats and resources of relevance for native fauna. Features present along the upgrade alignment include wetlands, mangroves, swamp forest, an array of wet and dry forest communities, rainforest, creeks and rivers, as well as

disturbed habitats such as pasture and grassland. Whilst some portions of the alignment are highly modified (agricultural lands and developed industrial areas) or are disturbed and degraded as a result of previous activities (agricultural activities, clearing, general access, weed-infestation *etc)*, other portions of the preferred alignment (Route A2) retain high quality habitat and resources for native fauna species.

Several wetland types are present along or near the proposed road corridor, including salt marsh, mangrove swamp forest, casuarina swamp forest and fresh water wetland. These habitats and features, indicated in the vegetation mapping for the proposed upgrade (Figure 8), provide resources and features of particular relevance for amphibians, wetland birds (including JAMBA and CAMBA species) and a few mammal species (such as the Large-footed Myotis).

The salt marsh on the southern side of the Brunswick River, and salt marshes located north of the river (west of the proposed alignment) provide resources and habitat for a number of migratory and nomadic wading bird species (such as curlews, ducks, herons and egrets). Other small freshwater wetlands in the general locality (including farm dams) also provide resources for wetland bird species (including ducks, grebes and herons), notwithstanding their often artificial nature.

Creeklines and swamps provide an array of habitat features for amphibians, wetland birds, riparian species and microchiropteran bats, and include habitats which are generally somewhat modified or degraded. However, these features provide resources which are generally restricted in distribution (in terms of the alignment itself), although are relatively widespread in the general locality and are well-represented in conservation reserves.

The other wetland community present which provides resources and habitat features of particular relevance for native fauna is mangrove swamp and woodland. Mangrove communities are extensive along the northern and southern shores of the Brunswick River, and provide an array of features and resources of particular relevance to certain native fauna in the locality. In particular, two threatened bird species are known to occur primarily in mangrove forest communities, and have been recorded on the north side of the Brunswick River (Kinhill 1996). Several migratory bird species, as listed under JAMBA and CAMBA, have also been recorded in the mangroves and mudflats along the Brunswick River. Mangroves are also important habitat for aquatic species, and are regarded as significant elements in the maintenance of healthy fish stocks.

The Brunswick River also provides habitat for a variety of fish species and aquatic invertebrate species. Common invertebrate species that have been recorded in the River in previous studies include the bivalve mollusc *Glancomome* cf *australis*, the polychaete worm *Nemphtys australis*, Soldier Crab *Mictyris platycheles* and the Semaphore Crab *Heloecius cordiformes* (Parker 1992). Most of the species recorded in the Brunswick River estuary are widespread in the estuaries of southeastern Australia (Jones *et al* 1986; Jones 1987).

The fish community of the Brunswick River is expected to be similar to that found in other rivers on the northern NSW coast. Studies of the Clarence and Richmond Rivers (based on commercial and recreational catches) indicate a variety of commercial and other fish species, including Sea Mullet *Mugil cephalus*, Yellowfin Bream *Acanthopagrus australis*, Dusky Flathead *Platycephalus fuscus*, Luderick *Girella tricuspidata*, Mulloway *Argyrosomus hololepidotis*, Tailor *Pomatomus saltatrix* and Sand Whiting *Sillago ciliata* (West & Gordon 1994). Pilchards, Sand Mullet and Leatherjackets are also typical of these rivers (Scribner & Kathuria 1996).

As noted above, an array of forest and woodland communities are present along Route A2. Forests present within the area to be affected by the proposal include moist and dry sclerophyll communities, and an array of rainforest types (Section 4; Figure 8).

The moist and dry sclerophyll communities include forest and woodland dominated by Tallow-wood, Blackbutt, Brush Box and an array of mid-storey species. These are generally located on the more elevated portions of the alignment, and provide specific habitats and resources for forest and woodland-dependent birds, arboreal mammals (including the Koala), microchiropteran bats and an array of reptile and amphibian species. Small areas of these vegetation communities and fauna habitats occur throughout the alignment, with major stands occurring in the central portion (near Coolamon Scenic Drive), and in the

north (although few of these areas would be affected by the proposal). Resource features and elements of relevance for native fauna include hollow-bearing trees (which are not common along the proposed alignment), hollow logs and other forest litter, the vegetation canopy and understorey plants. Generally, those areas which are to be affected by the proposal are already somewhat disturbed or modified from their original condition.

Rainforest communities along the alignment are highly varied, but have generally been modified as a result of previous clearing, disturbance (*eg* access tracks, weed-infestation *etc)*, and edge-effects from the existing highway. Nevertheless, rainforest communities provide resources of particular relevance for a number of native fauna species and groups, including rainforest pigeons and other frugivorous birds, several amphibian species, arboreal mammals and some bats, including the Queensland Blossom Bat.

The remainder of the proposed road corridor occupies agricultural lands, areas of industrial development and other modified landscapes. Whilst pasture and grassland provide resources for some native fauna species, these habitats are neither restricted in extent nor considered of particular concern, given the generalist nature of the fauna species which utilise these communities.

5.2.2 Fauna Species Recorded

An inventory of fauna species was compiled during the field surveys in the study area for the proposal. These records were supplemented with information from previous investigations in the immediate vicinity and surrounding area, and from the NP&WS Wildlife Atlas and the Birds Australia (RAOU) databases (Appendix 4). With regard to the NP&WS Atlas records, only those species recorded within approximately 10km of the existing alignment were considered relevant for discussion.

A total of 119 native vertebrate fauna species were recorded during the fauna surveys conducted within the upgrade study area, including eighty-three birds, eighteen mammals (including two megachiropteran and four microchiropteran bats), thirteen reptiles and five amphibians (Appendix 4). A number of additional fauna species which have been recorded in the general area during previous investigations (Appendix 4), could also potentially occur in the general vicinity of the proposed upgrade, given the wide variety of habitat types present.

Six threatened fauna species (TSC Act) were recorded during the fauna investigations in the study area and in the immediate vicinity, but no nationally threatened species (ESP Act) occur in the vicinity. A range of additional species of conservation concern recorded previously in the general area could potentially occur in the vicinity of the study area, at least on occasion (Appendix 4). Threatened species recorded during this survey are discussed in detail in Section 5.2.3. The relevance of other threatened fauna species recorded previously in the general area is considered in Section 5.3.

Birds

The range of different habitat types within the study area provide roosting, nesting and foraging resources for a wide variety of birds. Eighty-three native bird species were recorded during the fauna investigations (Appendix 4), the majority of which are common to abundant and widespread in distribution.

Thirty-nine species of native passerine birds were recorded during the field investigations conducted in the study area (Appendix 4). The species recorded are representative of a variety of guilds, including insectivores (*eg* thornbills, scrubwrens, fantails and fairy-wrens), pollinators (*eg* honeyeaters), ground-feeders (*eg* the Eastern Whipbird and Richard's Pipit), fruit and seed-eaters (*eg* the Satin Bowerbird, Olive-backed Oriole and Mistletoebird) and scavengers (*eg* the Pied Currawong, Grey Butcherbird and Australian Raven).

Forty-four non-passerine native bird species were recorded in the study area, including a variety of wetland birds, doves and pigeons, cockatoos and parrots, the Kookaburra, Sacred Kingfisher and Dollarbird (Appendix 5).

The majority of the bird species recorded are dependent primarily on the habitats provided by woodland and forest communities, ranging from dry open eucalypt forest to moist sclerophyll and rainforest. Characteristic diurnal species in woodland and forest habitats in the study area include the Black-faced Cuckoo Shrike, Grey Fantail, Satin Bowerbird, Brown Thornbill, and a wide variety of honeyeaters, thornbills, scrubwrens and fairy-wrens. Several nocturnal species, including the Southern Boobook and Tawny Frogmouth were also recorded in woodland and forest communities during the field investigations.

An array of additional woodland and forest bird species, not recorded during the current investigation, have been recorded during previous investigations in the region, including a number of threatened species (Kinhill 1996; Milledge & McKinley 1992). Given the extent of woodland and forest communities in the surrounding area, it is likely that many of these additional species could occur in the locality, at least on an occasional or transitory basis. Relevant species of conservation concern are discussed further in Section 5.3 of this report.

Avian species that utilise the groundcover or soil and soil litter within rainforest and forest communities comprise a separate guild or group of bird species. Birds which utilise the ground layers and groundcover include species typical of moister forest communities (*eg* the Australian Brush Turkey), and those more typical of drier forest and woodland communities (such as the Peaceful Dove and Emerald Dove).

Investigations in the rainforest and wet sclerophyll communities in the study area revealed the presence of a number of rainforest-dependent species, including the Australian Brush Turkey, Pale-yellow Robin, Spectacled Monarch and Figbird. No threatened rainforest bird species were recorded in the study area, although a number of species of conservation concern are known from the general area, including the Rose-crowned, Wompoo and Superb Fruit-doves and the Marbled Frogmouth (Section 5.3).

Twenty-three waterbird species were recorded within the study area during the field surveys, the majority of which were recorded in estuarine wetland, riverine and riparian habitats associated with the Brunswick River. Characteristic species include the Little Egret, Striated Heron and Bar-tailed Godwit, Pacific Black Duck, Australian Pelican and Little Black Cormorant (Appendix 4). Several species listed under JAMBA and/or CAMBA (including the Common Sandpiper, Great and Red Knots and Great Egret) were recorded in wetlands or on mudflats along the Brunswick River.

Two species of conservation concern were recorded in habitats along the Brunswick River during the fauna survey. The Osprey was recorded patrolling over the River and is likely to forage over other estuaries and coastal waters in the general area. This species has previously nested in the general vicinity, although the known nest site along the Brunswick River (Milledge & McKinley 1992) appears to be currently inactive. The Pied Oystercatcher was recorded foraging on mudflats in the vicinity of the existing highway crossing. Both the Osprey and the Pied Oystercatcher are listed as Vulnerable in NSW (TSC Act), and are discussed further in Section 5.2.3.

A range of additional wetland and coastal bird species have been recorded in the surrounding area (Appendix 4), including a number of threatened species. The relevance of these species to the proposal is discussed in Section 5.3.

Other bird species frequently recorded in the study area are characteristic of a range of natural and semi-natural environments, including agricultural lands and urban areas as well as open woodland and forest. Whilst generally relying on woodland and forest habitats for nesting and shelter, these species commonly utilise the largely cleared agricultural areas, road verges and suburban gardens in the general area for foraging. Species typically recorded in these environments include the Galah, Crested Pigeon, Magpie-lark, Willie Wagtail, Australian Magpie and Welcome Swallow.

Mammals

Eighteen native and two introduced mammal species were recorded during field surveys in the study area north of the Brunswick River (Appendix 4). A further twenty-two mammal species have been recorded in the surrounding area (Appendix 4), some of which may also potentially occur in areas of suitable habitat in the general vicinity of the proposed alignment.

Five small mammal species were recorded during Elliott trapping surveys, including three native species (the Bush Rat, Brown Antechinus and Fawn-footed Melomys), and two introduced species (the House Mouse and the Black Rat). The Bush Rat was the most frequently and widely captured species, with individuals being obtained at seven of the nine trapping sites (Appendix 5). The Brown Antechinus was recorded at two trapping sites located in rainforest communities immediately north of the Brunswick River (Appendix 5). Both species are common to abundant and widespread throughout a variety of forested habitats in eastern NSW, generally occurring at highest densities where there is a thick groundcover and abundant logs.

The Fawn-footed Melomys was recorded at two trap locations characterised by rainforest and wet sclerophyll forest communities with moderate levels of disturbance (*eg* weed invasion). This species is regarded as rare in NSW by Redhead (1995), but is not listed as a threatened species on the TSC Act. Suitable habitat for the Fawn-footed Melomys appears to be widespread in the general surrounding area.

The Northern Brown Bandicoot was captured in wet sclerophyll forest along trapline 2, to the south of Brunswick River and east of the existing highway. The groundcover in this area is variable, due to a moderate level of disturbance, with some areas supporting dense stands of grasses and sedges. Hair samples of this species were also collected in hair tubes at traplines 1 and 10 (Appendix 5). The Long-nosed Bandicoot was also recorded during spotlighting surveys in the study area. Both species are regarded as common and widespread in suitable habitat within their respective ranges (Gordon 1995; Stodart 1995).

Only one macropod species (the Swamp Wallaby) was recorded in the study area, from hair samples collected in hair tubes along the trapping transects (Appendix 5). The Swamp Wallaby is regarded as "*common*" within its range in Australia (Merchant 1995). The Red-necked Wallaby has also been recorded in the general area (Appendix 4), and is likely to occur in the study area based on the presence of suitable habitat.

Four arboreal mammal species (the Ringtail Possum, Mountain Brushtail Possum, Feathertail Glider and the Koala) were recorded during fauna surveys in the study area. All four species rely on forest and woodland communities for their foraging and shelter requirements. The Ringtail Possum, Mountain Brushtail Possum and Feathertail Glider are regarded as widespread and common to abundant throughout their respective ranges in NSW (Strahan 1995). The Koala is listed as a Vulnerable species under Schedule 2 of the TSC Act, and is discussed further in Section 5.2.3.

Two additional arboreal mammal species of conservation concern (the Squirrel Glider and Brush-tailed Phascogale) are known from the general area (Appendix 4), and could also potentially occur in areas of suitable habitat in the general vicinity. The specific habitat requirements of the Squirrel Glider have been discussed in Section 5.1.3 above, and the Brush-tailed Phascogale is discussed in Section 5.3.2 below.

A range of bat species were recorded in the study area, including two megachiropteran bats species. The Queensland Blossom Bat was recorded in harp traps in rainforest north of the Brunswick River. This species is considered Vulnerable in NSW and has been discussed in detail in Section 5.1.3. The Grey-headed Flying Fox, a widespread and common species in northeastern NSW, was also recorded during nocturnal surveys in the study area.

Four microchiropteran bat species were recorded in the study area during the fauna investigations, through call recording and harp trapping activities (Appendix 5). Of the species recorded, the Eastern Long-eared Bat and the Little Bent-wing Bat are listed as Vulnerable species under the TSC Act, and are considered further in Sections 5.1.3 and 5.2.3 respectively.

A further eight microchiropteran bat species have been recorded in the general area during previous investigations (Appendix 4). The majority of the species recorded in the study area and those that are likely to occur are hollow-roosting species, including the Eastern Long-eared Bat, Eastern Freetail Bat, Chocolate Wattled Bat, Gould's Wattled Bat, Lesser Long-eared Bat and Eastern Forest Bat. The remainder, including the Little Bent-wing Bat and the Large-footed Myotis (both threatened species under the TSC Act), roost primarily in caves or artificial structures (such as tunnels and mines). No suitable roosting caves or features for cave-dwelling bats are present along the proposed alignment.

Mammal species of conservation significance recorded during the field investigations in the study area are discussed in Section 5.2.3. Additional mammal species of conservation concern which have been recorded in the general area (Appendix 4), are considered further in Section 5.3.

Reptiles

Thirteen reptile species were recorded during the field investigations in the proposed upgrade study area, including 1 pygopid, 2 dragons, 1 varanid, 6 skinks, 1 blind snake and 2 snakes (Appendix 5). All of the species recorded have widespread distributions in eastern NSW and are generally common to abundant in status (Cogger 1992).

Twenty additional reptile species have been recorded during previous fauna investigations in the surrounding area, including a variety of skinks and snakes, as well as legless lizards, blind snakes and dragons (Appendix 4). The majority of these reptiles are widespread and abundant throughout a variety of habitats in eastern NSW and could also potentially occur in areas of suitable habitat in the vicinity of the proposed study area.

No threatened reptile species were recorded during the field investigations along the proposed upgrade alignment, nor have any been recorded during previous fauna investigations in the immediate vicinity and general surrounding area (Appendix 4).

Amphibians

A combination of warm temperatures and periods of rain prior to the commencement and during the fauna investigation provided ideal conditions for amphibian surveys, with individuals of a variety of species being both highly active and vocal. Five amphibian species were recorded in the upgrade study area, either through direct observation and/or using call identification (Appendix 4 & 5). All of the species recorded are considered widespread and generally common in areas of suitable habitat in northeastern NSW.

A further eighteen amphibian species have been recorded in the surrounding area during previous investigations (Appendix 4), some of which could also potentially occur in areas of suitable habitat in the general vicinity. As noted above (Section 5.1), twelve amphibian species were recorded along the Bypass duplication (which is generally of greater value for amphibians).

Five amphibian species of conservation concern are known to occur in the region, although none have been recorded in the vicinity during previous investigations or during surveys for this proposal (Section 5.3). No evidence for any of these species was detected during the current field investigations, despite targeted surveys for some species in areas of suitable habitat (Appendix 2).

5.2.3 Fauna Species of Conservation Significance

Six threatened fauna species were recorded during investigations in the study area (Table 5.2; Appendix 5; Figure 10). The species recorded and their specific habitat requirements are discussed briefly below, with detailed species profiles provided in Appendix 7. The potential impacts on these fauna species as a result of the proposed upgrade are discussed in Section 6. A detailed assessment of the significance of potential impacts on the threatened fauna recorded along the proposed upgrade alignment, under Section 5A of the NSW EP&A Act, is provided in Appendix 9.

A range of additional threatened fauna species are known from the surrounding area, some of which may also occur in the general vicinity of the proposed upgrade on occasion. The relevance of these species to the proposed upgrade is discussed further in Section 5.3.

Non-flying Mammals

- Koala

The Koala *Phascolarctos cinereus* has a patchy and poorly understood distribution amongst favoured forest types and associated tree species throughout northeastern NSW (NEFBS 1994). The habitats favoured by Koalas comprise open eucalypt forest and woodland, containing a variety of preferred tree species, depending on locality and seasonal conditions (Pahl *et al* 1991).

Table 5.2 Locations of threatened fauna species recorded during field surveys in the study area for the proposed upgrade, Brunswick to Yelgun (Figure 10).

STUDY AREA & SPECIES	STATUS	LOCATION	GRID REFERENCE	METHOD OF DETECTION
Koala	V	Brunswick NR	6843800 552900	Koala scats
		Billinudgel NR	6848900 552500	Koala scats
			6844050 551500	spotlight surveys
			6844300 551550	spotlight surveys
Queensland Blossom Bat	V	Harp trap No 2	6844100 552150	Harp trap
Little Bent-wing Bat	V	Banana Road	6845100 551500	Anabat II recorder
Eastern Long-eared Bat	V	Harp trap No 2	6844100 552150	Harp trap
		Harp trap No 3	6847150 551800	Harp trap
Osprey	V	Brunswick River	6843600 552500	observation
Pied Oystercatcher	V	Brunswick River	6843350 552200	observation
		Brunswick River	6843350 553700	observation

? tentative call identification
V Vulnerable Species (TSC Act)

During the fauna investigations, two Koalas were observed during spotlighting surveys in Blackbutt wet sclerophyll forest along Banana Road. Koala scats were only located in eucalypt communities in the Brunswick and Billinudgel NRs, not in rainforest vegetation in these Reserves. However, heavy rainfalls prior to the commencement of the fauna survey may have affected the results of the Koala scat surveys.

Koalas appear to be widespread, although at low densities, throughout the general locality (NP&WS Atlas; Oehlman 1997; Kinhill 1996; Milledge & McKinley 1992), and could potentially occur in any suitable stands of native forest or woodland in the vicinity of the proposed upgrade route. A variety of preferred Koala food tree species occur within the forest and woodland communities along the preferred Route A2 alignment, including Forest Red Gum *Eucalyptus tereticornis*, Swamp Mahogany *E robusta* and Tallow-wood *E microcorys*.

Two Koala black-spots have been reported along the existing highway (R Oehlman local resident *pers comm*), in the northern part of the study area. Koalas are occasionally recorded as roadkills near the Marshall's Creek crossing of the existing highway and in the north, near Dirty Flat Road.

Megachiropteran Bats

- Queensland Blossom Bat

The habitat requirements of the Queensland Blossom Bat are detailed in Section 5.1.3.

This species was recorded during harp trapping surveys in rainforest just north of the Brunswick River and near paperbark woodland along the proposed Brunswick Heads Bypass duplication to the south. The Queensland Blossom Bat is likely to forage through

extensive areas of suitable coastal forest, woodland and shrubland communities in the surrounding area.

Microchiropteran Bats

- Little Bent-wing Bat

The Little Bent-wing Bat occurs along the coast and ranges of northeastern NSW, becoming increasingly coastal towards the southern end of its distributional range in the mid-north coast area. It roosts during the day in caves and tunnels, and depends upon specific nursery cave sites to rear its young and for winter hibernation (Dwyer 1995). All known maternity or hibernation caves utilised by this species[7] are located near relatively large areas of dense vegetation, including rainforest, wet sclerophyll forest or coastal Banksia scrub (Gilmore & Parnaby 1994). Foraging activities appear to be concentrated between the understorey and canopy of vegetation communities, including forest and woodland communities within the species' range.

Calls of the Little Bent-wing Bat were recorded using an Anabat II recorder in open forest near Banana Road along the proposed upgrade alignment (Table 5.2; Figure 10). Several additional records of the Little Bent-wing Bat are known from the vicinity of the study area (NP&WS Wildlife Atlas; BSPC 1996; MKES 1994). The forest and woodland communities within the study area are likely to contribute to the foraging resources for Little Bent-wing Bats in the general vicinity, but do not support any potential roosting or nursery sites for this species.

- Eastern Long-eared Bat

The habitat requirements of the Eastern Long-eared Bat have been outlined in Section 5.1.3, above.

This species was recorded during harp trap surveys along the proposed upgrade alignment, near the Brunswick NR in the south of the study area and near Billinudgel NR in the north, as well as near the Brunswick Heads Bypass to the south. It has been recorded during numerous previous investigations in the general vicinity and is likely to occur widely through suitable forest and woodland habitat in the surrounding area.

Avifauna

- Osprey

The Osprey *Pandion haliaetus* has a disjunct distribution around the Australian coastline, and is much more numerous in the north than the south (Lindsey 1992). It occurs on off-shore islands and in littoral habitats, terrestrial wetlands and coastal lands of tropical and temperate Australia, often ranging inland along large rivers (Marchant & Higgins 1993). The Osprey requires extensive areas of clear open water (fresh, brackish or saline) for fishing, and nests in prominent positions (such as on rocky headlands or cliffs, or in tall trees with dead crowns or stags), usually in the vicinity of the ocean, along rivers or near large waterbodies.

The Osprey was recorded over the Brunswick River during the field surveys conducted in the study area, and has been recorded in previous investigations in the general area (Appendix 4). Milledge & McKinley (1992) identified an active Osprey nest along the eastern side of the Brunswick River to the west of the proposed Bypass. Recent investigations indicate that this nest is no longer active, and it appears that the birds may have moved to a site on the western bank of the Brunswick River downstream, further west of the Bypass.

[7] There are no known maternity or hibernation caves for the Little Bent-wing Bat in the study area.

- Pied Oystercatcher

The Pied Oystercatcher is distributed around the entire Australian coast, including on some off-shore islands. It is mainly associated with intertidal mudflats and sandbanks in large marine embayments or estuaries, but also occurs on sandy ocean beaches (Marchant & Higgins 1993). Favoured roosting sites include sandy beaches, spits, small sheltered islets and occasionally mangroves, usually located near mudflats where birds forage for molluscs, crustacea and small fish. Nest sites are located immediately above the high watermark on beaches, sandbars, along the margins of estuaries and lagoons and sometimes in saltmarsh communities (Marchant & Higgins 1993).

The Pied Oystercatcher was recorded during the field surveys, roosting and foraging on the intertidal mudflats of the Brunswick River, east and west of the existing Brunswick River Bridge. This species has also been recorded in the general vicinity during numerous previous investigations (Appendix 4). However, the areas to be affected by the proposed upgrade do not constitute relevant or significant habitat for the Pied Oystercatcher.

5.3 OTHER FAUNA SPECIES of CONSERVATION SIGNIFICANCE

A substantial number of other threatened fauna species have been recorded in the vicinity of the proposed upgrade at Brunswick Heads. Amongst these are species dependent on woodland and forest communities (and the resources and habitat features they contain), species dependent upon rainforest, species which depend on wetland or swamp habitats or on riparian vegetation communities, and species which are coastal or pelagic in habits and depend primarily on the marine environment (Table 5.3).

Of the 59 species of threatened fauna which are known to occur in the general locality, but not recorded in this project (Table 5.3), many utilize habitats or resources not present along the alignment, and only a few are considered likely to occur within the areas to be affected along the proposed upgrade alignment other than on occasions. It is considered unlikely that populations or even individuals of most of the potential species would be dependent on the habitats and resources to be affected by the proposal for their survival or conservation in the locality, given the existing levels of disturbance or habitat modification which have occurred.

As noted above (Section 5.1) previous investigations for the Brunswick Heads Bypass (Milledge & McKinley 1992) identified the presence of the Eastern Grass Owl and Long-nosed Potoroo in this locality. However, neither species is regarded as tolerant of high levels of ongoing disturbance (such as associated with major roadways), although both species can utilise artificial or modified habitats. Nevertheless, it is considered unlikely that either the Eastern Grass Owl or Long-nosed Potoroo would utilise those areas of habitat and resources immediately adjacent to the existing Brunswick Heads Bypass which will be affected by the proposed duplication.

Species dependent on coastal or pelagic environments are not likely to be present, with the exception of individuals of a few species which may occur along the Brunswick River. Similarly, the wetland and swamp communities and habitats which are present in the general locality are either highly disturbed or of restricted distribution along the proposed Route A2 alignment, and it is considered extremely unlikely that any of these species would be present, or be affected by the proposal to any significant extent.

Riparian vegetation communities and habitats are rare along the proposed Route A2 alignment for the proposed upgrade at Brunswick, with Marshall's Creek (and to a lesser extent the Brunswick River) being the only localities which could potentially or theoretically provide suitable habitat for threatened riparian fauna species such as the Bush hen and the Bitterns. As noted below, no evidence for any of these species has been obtained during the investigations for this report, although the Bush-hen has been recorded in the locality.

With respect to woodland and forest communities and to rainforest vegetation, the proposed development will involve impacts upon some areas of these communities and the resources which they support (Section 6 of this report). Conversely, the proposal has involved the selection of a route option which minimises the potential for adverse impacts being

imposed upon these communities and habitats, and which limits the likelihood of adverse impacts being imposed upon species which utilise these sites. Notwithstanding the absence of records for any of the threatened fauna species listed in Table 5.3 during the field investigations conducted for this report, several species are considered likely to be of some relevance to the proposed activity, and several have been recorded in the vicinity.

Table 5.3 Habitat preferences of threatened fauna species recorded in the general vicinity of the proposed upgrade at Brunswick Heads (Appendix 4), but not recorded during investigations along the alignment.

Woodland/Forest	**Rainforest**
Square-tailed Kite	Suburb Fruit-dove
Red Goshawk	Rose-crowned Fruit-dove
Bush Stone Curlew	Wompoo Fruit-dove
Glossy Black Cockatoo	Double-eyed Fig Parrot
Red-tailed Black Cockatoo	Marbled Frogmouth
Swift Parrot	Albert's Lyrebird
Regent Honeyeater	Olive Whistler
Painted Honeyeater	White-eared Monarch
Powerful Owl	Barred Cuckoo-shrike
Masked Owl	Black Flying-Fox
Sooty Owl	Pouched Frog
Grass Owl	
Long-nosed Potoroo	
Brush-tailed Phascogale	
Common Planigale	
Yellow-bellied Sheathtail Bat	
Eastern Freetail-bat	
Large-footed Myotis	
Large Pied Bat	
Wetland/Swamp	**Coastal/Pelagic**
Freckled Duck	Wandering Albatross
Magpie Goose	Red-tailed Tropicbird
Black-necked Stork	Gould's Petrel
Brolga	Black-winged Petrel
Comb-crested Jacana	Flesh-footed Shearwater
Bush-hen	Great Knot
Black Flying-Fox	Little Tern
Green & Golden Bell Frog	Sooty Oystercatcher
Wallum Frog	Beach Stone-curlew
Wallum Sedgefrog	Sanderling
	Lesser Sandpiper
	Greater Sandpiper
	Terek Sandpiper
Riparian	
Black Bittern	
Australasian Bittern	
Collared Kingfisher	
Mangrove Honeyeater	
Black Flying-Fox	
Gold-eyed Barred Frog	

Of the species listed in Table 5.3, most (as noted above) are not considered of relevance to the proposal, because of the nature and condition of the habitats present along Route A2, because of existing levels of disturbance, or because they are highly mobile and the area to be affected by the proposal does not support resources or habitat features critical to their survival or conservation.

In this respect:

- coastal and pelagic species (*eg* the Little Tern, albatrosses, marine mammals) are not expected to occur along the alignment, given the absence of suitable habitat for these species;

- species dependent on wetland and swamp habitats (*eg* the Comb-crested Jacana, Wallum Froglet, Wallum Sedge-frog and Green & Golden Bell Frog) will not be affected, given that no significant clearing of suitable wetland habitats is required and given the implementation of measures to avoid adverse impacts on wetlands in the general vicinity of the alignment;
- no adverse impacts on either the Black-necked Stork or Brolga are likely, given both species' rarity in the general area and the lack of suitable or significant habitat;
- the Black and Australasian Bitterns are not expected to be adversely affected by the proposal, even if they occur in the locality, because of a scarcity of suitable habitat, and because impacts at sites which are of potential value (*eg* Marshall's Creek) are to be confined substantially to areas already affected by the Pacific Highway. No undisturbed or unmodified habitat for these species is present, and there is no likelihood of any "*significant effect*" being imposed on them, even if they are present (see s.5A Assessment for the Bush-hen); and
- the additional woodland and forest species (Table 2) are not considered relevant on the basis of the relatively small areas of potential habitat to be removed, the existing levels of disturbance in the locality and their mobility. Species of relevance in this regard include the Regent Honeyeater, Black Flying-fox, Sooty Owl and Glossy Black Cockatoo.

Whilst a number of threatened fauna and flora species additional to those considered above (Section 1.8) have been recorded during previous investigations in the general vicinity of the proposal (within approximately 1km), the lack of records for these species despite intensive and targeted surveys, and the extent of disturbance along the proposal alignment (Route A2 and the Brunswick Heads Bypass duplication), as well as the disturbed and modified nature of most of the areas to be affected, suggests that whilst a "*significant effect*" is possible, it is not "*likely*". In this regard:

- no evidence for the Long-nosed Potoroo was obtained from either the duplication study area or the Route A2 study area, despite extensive and appropriate field investigations;
- there are no records of the Common Planigale from either the duplication or Route A2 study areas, nor was this species recorded by Milledge & McKinley (1992). There is no record of the Common Planigale from the study area, and its ability to utilise a range of habitats and environments suggests that the imposition of "*a significant effect*" is not "*likely*";
- no evidence for the Eastern Grass Owl was obtained from the study areas, despite dedicated and appropriate survey methods. This species is not likely to utilise the Bypass duplication study area, and potential habitat occurs close to, but not along, Route A2; and
- no threatened amphibian species were recorded from the proposal study areas, despite investigations under appropriate and suitable conditions. Furthermore, those areas of potentially suitable habitat which are to be affected along the proposal are limited and generally modified or disturbed.

On the basis of the above considerations, there is no likelihood of any "*significant effect*", being imposed on these additional species of conservation concern known from the locality or regarded as potentially occurring.

Furthermore, the proposal has been specifically located and designed to minimise the potential for adverse impacts to be imposed upon any threatened biota or their habitats at this location. Measures are incorporated into the design of the project and will be implemented as part of its construction to avoid affecting these species. Consequently, these species have not been considered individually in the s.5A Assessments of Significance with respect to the proposed Pacific Highway project at Brunswick Heads.

Conversely, a few of those species listed in Table 5.3 have been recorded in the general locality, and utilise resources which are present along Route A2. Several of these species (Table 5.4) are considered likely to occur along the alignment, at least on occasions, and are considered under Section 5A of the EP&A Act (Appendix 9) on the basis of adopting a

'precautionary' approach to the consideration of impacts in this EIS. Those species not considered under s.5A (*ie* those not listed in Table 5.4) are regarded as only possibly present along Route A2, and are not considered "*likely*" to be subjected to "*a significant effect*", although an adverse impact is possible.

Included amongst those species which have not been recorded along Route A2 but which are regarded as likely to occur or which may potentially occur, and which could potentially (at least) be affected by the proposal, are:

- the Bush-hen, which has been recorded along Marshall's Creek and could occur (at least theoretically) in the vicinity of the existing highway;
- the Collared Kingfisher, which has been recorded in mangroves along the Brunswick River and which could (theoretically at least) be affected by the removal of mangroves for the proposal;
- the Mangrove Honeyeater which has also been recorded in mangroves along the Brunswick River and could be similarly affected; and
- the Superb Fruit-dove, Rose-crowned Fruit-dove and Wompoo Fruit-dove, which have been recorded in the general locality, and, being rainforest-dependent, could potentially be affected by the removal of vegetation in Smokey Valley.

Table 5.4 Threatened fauna species regarded as of relevance to the proposal (Route A2), on the basis of records and/or habitat requirements.

Common Name	**Scientific Name**
Koala	*Phascolarctos cinereus*
Squirrel Glider	*Petaurus norfolcensis*
Queensland Blossom Bat	*Syconycteris australis*
Little Bent-wing Bat	*Miniopterus australis*
Wompoo Fruit-dove	*Ptilinopus magnificus*
Osprey	*Pandion haliaetus*
Eastern Long-eared Bat	*Nyctophilus bifax*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Bush-hen	*Amaurornis olivaceus*
Pied Oystercatcher	*Haematopus longirostris*
Sooty Oystercatcher	*Haematopus fuliginosus*
Rose-crowned Fruit-dove	*Ptilinopus regina*
Superb Fruit-dove	*Ptilinopus superbus*
Collared Kingfisher	*Todiramphus chloris*
Mangrove Honeyeater	*Lichenostomus fasciogularis*

Whilst a number of the other threatened species listed in Table 5.3 could theoretically or potentially occur along Route A2 on occasions, none are considered likely to occur other than as individuals or sporadically. It is not considered likely that there is "*a viable local population*" of any of these species (s.5A of the EP&A Act) present along Route A2, and the proposal is not regarded as likely to impose "*a significant effect*" on any of these species.

Furthermore, the impact amelioration measures incorporated into the proposal, as documented in Chapter 7 of this report, will ensure that significant adverse impacts will not be imposed upon any of these species or their habitats. The proposal has been located and designed, and will be constructed and maintained, in a manner based on the principles of ESD, and particularly to avoid the imposition of significant impacts upon threatened biota or their habitats (see Section 6).

The *NSW Fisheries Management Act 1994* (FM Act) has amended the schedules of threatened species (Schedules 1 and 2 of the TSC Act) by including 3 Endangered fish species and one Vulnerable fish species. The 4 listed fish are freshwater species, and have not been recorded

in the locality. Given the environmental management measures proposed, these species are not of relevance with respect to the proposal.

5.4 THREATENED SPECIES (Commonwealth)

Eight threatened fauna species, listed under the Commonwealth ESP Act, have been recorded in the region, although none of these species was recorded along Route A2 or in the immediate vicinity during the field investigations conducted for this report. Three of the threatened Commonwealth species (Gould's Petrel, the Wandering Albatross and the Little Tern) are associated with beaches and marine environments, and there is no suitable or relevant habitat along the proposal or in the vicinity.

Other threatened bird species (the Red Goshawk, Double-eyed Fig-parrot, Swift Parrot and Regent Honeyeater) could potentially or theoretically occur along the alignment, but there are no records for these species in the immediate vicinity and they were not recorded during field investigations for this report. Furthermore, given their wide-ranging and highly mobile habits, and the absence of any special or particular habitats or resources for them along Route A2, no adverse impacts are regarded as likely to arise from the proposal on these species or their habitats.

Similarly, no evidence for the Green & Golden Bell Frog has been recorded from the alignment or in the general vicinity. This species is not regarded as of particular relevance with respect to the proposed Pacific Highway upgrade at Brunswick Heads.

The ESP Act lists 11 Endangered (Part 1 of Schedule 1) and 10 vulnerable (Part 2 of Schedule 1) fish species which are considered Endangered or vulnerable under the Act. Of these, only 2 (the Great White Shark and Grey Nurse Shark) are marine species, with the remainder being freshwater fish. None of the fish species listed on the ESP Act are regarded as of relevance to the proposal.

5.5 JAMBA and CAMBA

With respect to migratory birds listed on JAMBA and CAMBA, a total of 39 species (Table 5.5) have been recorded in the general locality, including 31 species listed in CAMBA, and 35 species listed in JAMBA. However, many of these are species restricted to habitats which do not occur along Route A2 or in the immediate vicinity, whilst others (such as the White-bellied Sea-eagle, Glossy Ibis, Cattle Egret and Fork-tailed Swift) are either widely dispersed throughout the environment or are not specifically associated with features of Route A2.

Eight species listed in JAMBA and CAMBA (seven listed in CAMBA and eight in JAMBA) have been recorded during field surveys conducted for this report (Table 5.5). No significant impacts are expected on these species or on their environments, on the basis that:

- the Rainbow Bee-eater is a widely distributed species, and little relevant habitat is to be affected by the proposal;
- the White-throated Needletail is an almost exclusively aerial species, and is not likely to utilise Route A2 for any habitat or resource requirements;
- the Common Tern is a principally marine species, and may only occur along Route A2 at the Brunswick River. No removal of habitat or resources for this species will occur as a result of the proposal;
- the Ruddy Turnstone is unlikely to occur along the alignment, given the absence of suitable resources (involving rocky platforms, reefs and beaches with marine debris); and
- only an extremely limited area of suitable habitat for the Bar-tailed Godwit, Whimbrel, Eastern Curlew and Common Sandpiper is to be affected (primarily associated with the Brunswick River). Those areas which are to be affected by the proposal are already modified or disturbed by existing human activities.

Table 5.5 Migratory birds protected under bilateral agreements between the Australian Commonwealth and Japan (JAMBA[1]) and/or China (CAMBA[2]), known to occur in the general locality of the proposal (this study; previous investigations[3]). Those species recorded during field surveys conducted for this report are indicated in bold.

COMMON NAME	SCIENTIFIC NAME	JAMBA	CAMBA
Fleshy-footed Shearwater	*Puffinus carneipes*	✔	
Wedge-tailed Shearwater	*Puffinus pacificus*	✔	
Short-tailed Shearwater	*Puffinus tenuirostris*	✔	
Wandering Albatross	*Diomedea epomophora*	✔	
Lesser Frigatebird	*Fregata ariel*	✔	✔
Eastern Reef Egret	*Egreta sacra*		✔
Great Egret	*Ardea alba*	✔	✔
Cattle Egret	*Ardea ibis*	✔	✔
Glossy Ibis	*Plegadis falcinellus*		✔
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		✔
Latham's Snipe	*Gallinago hardwickii*	✔	✔
Bar-tailed Godwit	***Limosa lapponica***	✔	✔
Whimbrel	***Numenius phaeopus***	✔	✔
Eastern Curlew	***Numenius madagascariensis***	✔	✔
Marsh Sandpiper	*Tringa stagnatilis*	✔	✔
Common Greenshank	*Tringa nebularia*	✔	✔
Terek Sandpiper	*Xenus terek*	✔	✔
Common Sandpiper	***Actitis hypoleucos***	✔	✔
Grey-tailed Tattler	*Heteroscelus brevipes*	✔	✔
Wandering Tattler	*Heteroscelus incana*	✔	
Ruddy Turnstone	***Arenaria interpres***	✔	✔
Great Knot	*Calidris tenuirostris*	✔	✔
Red Knot	*Calidris canutus*	✔	✔
Sanderling	*Calidris alba*	✔	✔
Red-necked Stint	*Calidris ruficollis*	✔	✔
Sharp-tailed Sandpiper	*Calidris acuminata*	✔	✔
Curlew Sandpiper	*Calidris ferruginea*	✔	✔
Pacific Golden Plover	*Pluvialis fulva*	✔	
Lesser Sand Plover	*Charadrius mongolus*	✔	✔
Greater Sand Plover	*Charadrius leschenaultii*	✔	✔
Arctic Jaeger	*Stercorarius parasiticus*	✔	
Caspian Tern	*Sterna caspia*	✔	✔
Common Tern	***Sterna hirundo***	✔	✔
Little Tern	*Sterna albifrons*	✔	✔
Lesser Crested Tern	*Sterna bengalensis*		✔
Common Noddy	*Anous stolidus*	✔	✔
White-throated Needletail	***Hirundapus caudacutus***	✔	✔
Fork-tailed Swift	*Apus pacificus*	✔	✔
Rainbow Bee-eater	***Merops ornatus***	✔	

1 JAMBA: Agreement between the Government of Australia and the Government of Japan for the protection of Migratory Birds and birds in danger of extinction and their environment (1974).

2 CAMBA: Agreement between the Government of Australia and the Government of the People's Republic of China for the protection of Migratory Birds and their environment (1989).

3 See Appendix 4 for records from previous investigations conducted in the general locality and from fauna databases for the wider surrounding area.

6 POTENTIAL IMPACTS

6.1 INTRODUCTION

In terms of the natural environment, the construction of a major road (such as the proposal) will inevitably involve the imposition of impacts upon native biota and their habitats. Even in a degraded or highly modified environment, a road construction of the dimensions proposed at Brunswick Heads will involve adverse impacts upon the natural environment and upon native fauna and flora.

The potential or likely impacts on the natural environment which will arise as the result of major roadworks include both direct and indirect effects, and will vary in extent and significance in response to a number of factors. Direct effects (including the removal of vegetation and resources, and the loss of individual plants and animals) and indirect effects (including the loss of specific resources for certain species, the creation of barriers to fauna movements, and the discharge of water and contaminants from the roads) will depend on the nature and condition of the existing environment through which the road passes, the relevance of the vegetation which is to be affected (in terms of the general landscape), and the specific design and engineering approach to the road and to its construction, operation and maintenance.

In this regard, the Pacific Highway upgrade proposal has been located and designed, and is to be constructed and maintained, in an environmentally sensitive manner. In the first instance, the route selection process (Section 2) considered issues of the natural environment at considerable length, such that features of the natural environment and its protection were a significant determinant of the location of the preferred route for the proposal (Section 2.9).

Second, the proposed upgrade and the interchanges at the north and south have been specifically designed to minimise the disturbance footprint and to ensure that both direct and indirect impacts from the proposal are limited to the minimum possible. This has involved an ongoing process of consultation, discussion, review and re-design by the project team, to obtain the best possible design outcome.

Third, an array of impact amelioration and environmental management measures are incorporated into the project design, to avoid or minimise the imposition of adverse impacts and to remediate or compensate for effects which are imposed on the natural environment.

Finally, the overall impacts of the project on the natural environment are to be managed and/or offset by a range of impact amelioration and environmental management measures, including landscaping and habitat rehabilitation programs, and the provision of compensatory habitat to offset that lost.

On this basis, sections of the proposal have been located so as to minimise the potential for adverse impacts to be imposed upon the natural environment. In particular, the proposed duplication of the Brunswick Heads Bypass involves the construction of a second carriageway immediately adjacent to the existing construction, which involves areas which are already disturbed, thus limiting further degradation through the landscape. Similarly, the proposed upgrade of the highway between Brunswick and Yelgun (Route A2) has been located primarily in areas which are already substantially modified and altered from their original condition and/or avoids the clearing of currently non-fragmented and relatively undisturbed habitats elsewhere in the locality. The route selected also avoids the imposition of a novel barrier to fauna movement through relatively undisturbed areas, thus mitigating the potential adverse effects of the proposed upgrade.

In addition to selecting an alignment for the proposal in part to minimise the potential for adverse impacts on native fauna and flora, elements of the design and construction of the proposal have been incorporated specifically to mitigate potential impacts from the activity.

In this regard, in addition to the standard 'best practice' approaches to construction activities, sediment discharge, water quality control and other relevant matters implemented as corporate policy by the RTA, design and construction features of the

proposal specifically directed at the natural environment are included as elements of the activity. Construction activities in the vicinity of the Nature Reserves along the alignment will be stringently controlled and confined to the alignment footprint. Similarly, design of the proposed upgrade has involved confining the proposed road to the narrowest possible alignment at sensitive locations, and the use of retaining walls at some locations to minimise the footprint. These measures have all been incorporated as part of the activity, to mitigate the potential for adverse impacts to be imposed upon the natural environment, and thus to inherently reduce the impacts which might otherwise apply.

6.2 GENERAL IMPACTS

The principle effects and potential impacts on native fauna and flora and their habitats which could arise (unless addressed) as a result of road construction and operation include:

- habitat removal, involving the clearing of native vegetation, and the removal of habitat features and resources (such as hollow-bearing trees, swamps, heath, logs *etc*);
- the formation of barriers to animal movements, particularly for terrestrial and non-aerial mammals, reptiles and amphibians;
- habitat fragmentation, which may split populations or communities into smaller, and less viable, units;
- wildlife mortality as a result of collision with motor vehicles, which is of particular relevance to species such as bandicoots, Koalas, macropods and larger reptiles; and
- the disturbance and degradation of adjacent habitat as a result of clearing and construction activities, or as a result of the discharge of sediment during construction and water and contaminants both during and after construction. Increases in or the introduction of weed infestation, particularly along the interface between native vegetation and disturbed lands, and 'edge effects' are also of concern.

Habitat Removal

The direct removal of vegetation and habitats for the construction of roads in general can constitute a significant adverse impact on native biota, particularly in areas characterised by natural vegetation and in areas of high conservation value. Clearing for roads in general involves the removal of resources such as hollow-bearing trees, hollow logs, wetlands, food and foraging resources, and specific vegetation types, as well as the loss of individual plants and potentially some animals, where native vegetation is present.

Minimising the potential adverse impacts of the clearing required for road construction is generally achieved by the careful and appropriate location of the road, to minimise the area of clearing which is necessary.

In the case of the Brunswick Heads Bypass duplication, location of the roadworks immediately adjacent to the existing Bypass has enabled minimisation of the area of vegetation and habitat which requires clearing. On this basis, and given the existing and previous disturbance to lands in the immediate vicinity of the existing Brunswick Heads Bypass, the removal of habitat and resources which will be required for this element of the proposal is not considered significant in conservation terms. These habitats and resources are already modified and degraded, and their loss is not regarded as likely to constitute a significant impact with respect to the native biota in this locality.

Along the Brunswick Heads Bypass duplication approximately 2.2ha of swamp sclerophyll forest and 1.6ha of dry sclerophyll forest are located within the road corridor. Only a small proportion of these areas (less than 20%) will require removal for the duplication, because of previous clearing for the existing Bypass. In addition, the areas of these vegetation communities which do require removal are already substantially disturbed and modified.

One small patch of rainforest (of approximately 0.2ha) will also require removal (Table 6.1), but most of the regenerating rainforest in this locality is to be retained (Figure 7).

For the Brunswick to Yelgun portion of the project, both the selection of the Route A2 option and the specific design elements for the project have involved considerable measures to minimise the area of habitat and vegetation which requires clearing. Features of the design, including the use of retaining walls, maximal batter slopes, location criteria, and landscaping and rehabilitation protocols, are intended to minimise the area of vegetation and fauna and flora habitats which require clearing or disturbance for the proposal.

Table 6.1 Approximate areas of vegetation communities included within the road corridor at Brunswick Heads. In most instances, a substantial proportion (up to 40%) of each community will be retained with the road corridor.

Brunswick Heads Bypass Duplication		**Extent in Locality**
Swamp Sclerophyll Forest	2.2ha	moderate (>100ha)
Dry Sclerophyll Forest	1.6ha	moderate (>100ha)
Rainforest	0.2ha	limited (a few hectares)
Cleared/Disturbed Land	0.2ha	considerable (>>100ha)
Brunswick to Yelgun Upgrade		
Rainforest	4.2ha	moderate (>100ha)
Wet Sclerophyll Forest	6.5ha	considerable (>>100ha)
Swamp Sclerophyll Forest	3.9ha	moderate (>100ha)
Sedgeland	0.7ha	limited (a few hectares)
Mangroves	0.2ha	moderate (>100ha)
Saltmarsh	-	limited (a few hectares)
Cleared/Disturbed Land	33.9ha	considerable (>>100ha)

In most instances, the extent of individual vegetation communities which will require removal for the proposal constitutes only a small proportion of those communities in the locality (Table 6.1), and is of even less significance in terms of the region (the NSW North Coast region occupies an area of approximately 58189km^2 in NSW). The Brunswick to Yelgun upgrade portion of the proposal includes approximately 4.2ha of rainforest, 6.5ha of wet sclerophyll forest and 3.9ha of swamp sclerophyll forest within the whole road corridor (Table 6.1). Whilst portions of these vegetation communities within the corridor will be retained (Figure 8), up to 75% of some areas within the corridor appear likely to be removed. All of the modified sedgeland north of Marshall's Creek will be removed, although (as is the case with the other vegetation communities) the areas which will be affected by the Pacific Highway upgrade constitute only a small proportion of the vegetation communities in the locality.

Only a very small area of mangrove and mudflat (less than 0.2ha) is to be removed for the proposal (Table 6.1), and the saltmarshes in the vicinity are to be avoided in their entirety. Thus, little habitat of potential relevance for JAMBA or CAMBA bird species will be affected by the proposal.

Barrier Formation

Generally, roads have the potential to act as significant barriers to the movement of terrestrial fauna, as a consequence of the break in vegetation and protective cover, the levels of disturbance to roadside habitats, general disturbance generated by traffic, and wildlife mortalities (see below).

The barrier effect of roadways is of particular concern for terrestrial species, including small to moderate-sized terrestrial mammals, reptiles and amphibians. Roads can also constitute a significant barrier to gliding mammals (such as the Sugar Glider, Squirrel

Glider and Yellow-bellied Glider), particularly where substantial road systems are being installed. Depending on the road width and the availability of tall trees adjacent to the road, these gliding species may be prevented from crossing a wide carriageway (although the simple expedient of retaining some large trees, or erecting 'crossing poles' within a central nature strip could resolve the problem, in some instances).

Construction of the additional four lanes for the motorway along Route A2 doubtless provides a wider barrier to fauna movements, and will be associated with greater road speeds and traffic volumes over time. Conversely, for many of the threatened fauna species which could occur in the area, the existing two-lane Pacific Highway is (in essence) an absolute barrier to movements, in any case. Species such as the Koala, Long-nosed Potoroo and Common Planigale are likely (if present) to only successfully and safely traverse the existing highway on a rare occasion, if at all. For the Common Planigale, the existing Pacific Highway is highly likely to be an absolute barrier to movements at present.

Similarly, unless they can utilise existing drainage culverts across the highway, the Wallum Tree Frog and Wallum Froglet are unlikely to successfully and safely traverse the existing highway. The proposal, on the other hand, whilst widening the potential barrier to fauna movements, will involve the construction of larger than standard, as well as supplementary culverts beneath the road, including some specifically designed fauna underpasses. As a consequence, the potential for the additional roads to impose a significant barrier to fauna movements in the immediate vicinity is regarded as relatively low.

For most of the threatened fauna species known from the vicinity and from the locality (*eg* BSPC 1996), including microchiropteran bats and birds, the new roadway is not regarded as likely to impose any barrier to movements through this landscape.

Nevertheless, for the fauna species known to occur in the vicinity of the Brunswick Heads Bypass duplication and the Brunswick to Yelgun upgrade, the potential for the roadworks to provide a movement barrier is of particular concern with respect to the Koala, Long-nosed Potoroo (if present), bandicoots, small mammals, reptiles and amphibians in general. On this basis, dedicated fauna underpasses and above-standard drainage culverts are proposed (see Section 7).

Habitat Fragmentation

An associated impact which can arise from the construction of major roads is the fragmentation of habitats for native fauna and flora. Inappropriate placement of a roadway can fragment habitats and resources, splitting fauna or flora populations into separate groups and reducing overall population viability. Fragmentation of habitats and populations of native plants and animals can reduce the long-term viability of each of the small populations which arises from the process. In addition to reducing the viability of smaller portions of habitat and divided populations, habitat fragmentation has the potential to involve (for fauna at least) increases in individual mortality and the imposition of movement barriers.

In the case of the upgrade of the Pacific Highway at Brunswick Heads, the potential for habitat fragmentation has been limited by selection of Route A2 for the Brunswick to Yelgun portion of the activity. By locating the new road in the vicinity of the existing highway, the potential for habitat fragmentation has largely been avoided (through the exhaustive route selection process). Similarly, duplication of the Brunswick Heads Bypass by the addition of a second carriageway immediately adjacent to the existing Bypass avoids the potential for any increase in habitat fragmentation at this locality.

Wildlife Mortality

Roadworks in general have the potential to involve increases in individual animal mortality at a locality, particularly where a new road is being located through previously undisturbed landscapes. Wildlife mortality as a result of collisions with motor vehicles is of particular concern for terrestrial species, including macropods, Koalas, bandicoots, small terrestrial mammals, reptiles and amphibians (Andrews 1990; Fanning 1992).

As noted above, this issue is of particular relevance to species such as the Koala in the Brunswick Heads area, and there are two identified 'black spots' along the existing Pacific Highway, north of the Brunswick River. Whilst there is a potential for increasing wildlife mortality along a proposed road, the proposal will incorporate both design and construction measures to ensure that such potential impacts are not realised (Section 7).

Disturbance and Degradation of Adjacent Habitat

Both the construction and subsequent operation of any road has the potential to impose indirect adverse impacts on adjacent habitat, including areas of vegetation and habitat which are retained for conservation purposes.

During the construction phase, concerns regarding erosion and sediment discharge are generally addressed by an array of standard impact amelioration measures (such as silt fences, sediment ponds, mulching, matting *etc*). However, unless appropriately managed, erosion and sediment discharge can significantly affect adjacent vegetation communities, habitats or resources. Generally, these concerns are readily addressed, and the application of 'best practice' approaches to the management of sediment discharge along roads in NSW is standard practice.

Both during construction and subsequent operation of the proposal, a number of indirect effects on the local environment are possible, including the discharge of contaminants, alterations to the nutrient status of adjacent vegetation and soils (arising from road materials and discharges from vehicles), and alterations to water flows following rainfall events.

The disturbance to and (ultimately) degradation of natural vegetation communities and habitats which arises from roadworks activities often includes an increase in or the initiation of weed infestation. Alterations to hydrologic and nutrient regimes, the disturbance and exposure of soils, and the use of machinery and equipment which carry weed propagules can (and generally does) result in new weed species being introduced into an area of disturbance and an increase in the extent and intensity of weed infestations. The exposure of new edges of native vegetation can also result in significant weed infestations, unless appropriately managed.

The clearing of portions of native vegetation also frequently involves the creation of new interfaces between cleared or disturbed lands and native vegetation communities. Interface zones are generally subjected to 'edge-effects', which involve the exposure of portions of vegetation communities and of individual plants to altered microclimates and climatic factors (*eg* strong winds) not normally experienced. Other characteristics of 'edge-effects' may include weed infestation, mortality of trees and other native plants, changes in plant species' composition and changes in fauna assemblages.

Weed invasion and dieback of plants along newly created edges can be of particular concern with respect to rainforest vegetation communities, where many species are dependent upon moist microclimatic conditions. Conversely, there does not appear to be a significant level of dieback along existing artificial ledges of rainforest in the vicinity, although weed invasion is, in some areas at least, of concern. Both of these impacts upon rainforest and other native vegetation communities can readily be managed, by the implementation of appropriate protocols associated with the construction and rehabilitation phases of the proposal.

Management of these indirect impacts is somewhat more complex, and involves the acceptance of a certain (generally limited) level of environmental modification, at least temporarily (*ie* during construction) it is not possible to eliminate all modifications to water and contaminant flows, for example. Nevertheless, a number of measures are implemented as a matter of course in current road construction and management, including the use of water quality control ponds, macrophyte beds and appropriately engineered and managed structures for water discharge, weed control programs, and planting and landscaping regimes.

6.3 BRUNSWICK HEADS BYPASS DUPLICATION - POTENTIAL IMPACTS

As noted above, the proposed duplication of the Brunswick Heads Bypass involves the construction of a second (north-bound) carriageway, immediately to the west of the initial two-lane Brunswick Heads Bypass. The area proposed for the duplication is located within the existing road corridor for the Brunswick Heads Bypass, and will involve activities within a relatively narrow band of already disturbed and modified land.

The issues regarding fauna and flora in the area south of the Brunswick River through which the Brunswick Heads Bypass is located have been canvassed in detail in the EIS for that project and its accompanying Fauna Impact Statement (FIS), prepared by Milledge & McKinley (1992). In the FIS, Milledge & McKinley "*strongly recommended*" that the alignment which is now used "*be adopted because of its considerably lower adverse impact on the natural environment*".

6.3.1 Potential Impacts on Flora

General

The proposed duplication of the Brunswick Heads Bypass will, as noted above, involve the construction of a second carriageway immediately adjacent to that already completed. Given the existing levels of disturbance in this locality, arising in part from the current and previous construction activities for the Brunswick Heads Bypass and from previous clearing and grazing activities in the locality, the likelihood for significant adverse impacts to be imposed upon the native vegetation and plants in general is regarded as slight. The plant species and vegetation communities present which may or will be affected by the proposed duplication are generally common and relatively widespread, with the vegetation communities being, as noted above, moderately to highly disturbed and degraded. Furthermore, only small areas of these vegetation communities are to be removed (Table 6.1; Figure 8), and considerable areas of similar or identical vegetation are to be retained in the immediate vicinity and in the locality. The loss of individual plants or of portions of vegetation communities as a consequence of the proposed duplication is not considered a significant impact in terms of their local or regional conservation.

Whilst the proposed duplication of the Brunswick Heads Bypass will require the removal of some vegetation, this direct impact is considered of low significance with respect to the conservation of native flora in the locality. Similarly, the potential for indirect impacts on native flora and vegetation communities is considered slight, given the effects from the existing Bypass construction, and that appropriate measures will be applied along the Bypass duplication.

Species of Conservation Significance

No threatened plant species, as listed in Schedules 1 or 2 of the TSC Act, were recorded along the proposed corridor for the Bypass duplication. Similarly, no nationally threatened species (ESP Act) were recorded along the Bypass duplication study area. Furthermore, given the nature and condition of the vegetation communities present, and the existing levels of disturbance, it is not considered likely that the area of land to be disturbed by the proposed duplication is of critical value[8] for any such species, even if a few individuals were present.

No nationally recognised Rare Or Threatened Australian Plants (Briggs & Leigh 1996), or as listed on the ESP Act, were recorded along the proposed Brunswick Heads Bypass duplication alignment, and there will consequently be no adverse impacts upon any such species. As noted above, the proposal will be subject to the design, management and impact amelioration measures being implemented along the existing Bypass, and the proposal will consequently not involve the imposition of any significant increase in these impacts on species of national conservation significance.

Four plant species considered of regional conservation significance were recorded in this part of the study area, of which one may be affected by the proposal. The Burny Bean

[8] It is not considered likely that any threatened fauna would be dependant on the habitats and resources to be "*modified or removed*", or that "*a significant effect*" will be imposed upon any threatened fauna species.

Mucuna gigantea is a native vine, a population of which is growing on a stand of paperbarks along the proposed Bypass alignment. It appears likely that part of this population, at least, would be removed as a result of clearing for the proposal, although a proportion of the population will remain. Specific measures to ensure the conservation of this species in the locality, and in the immediate vicinity are provided in Section 7 of this report.

Section 5A Assessment of Significance

No "*threatened* [plant] *species, populations or ecological communities*" were recorded along the corridor for the proposed Bypass duplication, and there is consequently no likelihood of "*a significant effect*" being imposed upon any such threatened flora or vegetation communities. Furthermore, given the nature and condition of the area to be affected by the proposal, it is not considered likely that the activity will impose "*a significant effect*" on the habitat of any such species or populations.

Given the absence of threatened plants from this locality, and the lack of special or critical habitats or resources for any such species, a formal Section 5A Assessment of Significance is not required.

6.3.2 Potential Impacts on Fauna

General

The levels of existing disturbance associated with the alignment for the proposed Bypass duplication generally render the area of land to be affected of relatively low value for native fauna. The proposal will involve the construction of a second carriageway immediately adjacent to the current Bypass, in an area which has been affected both by the existing roadworks and by previous clearing and grazing activities. Whilst there are some resources for native fauna which will require removal for the proposed duplication, these are not considered critical to the conservation or survival of any native fauna species in the general locality.

Similar considerations also apply with respect to the potential for indirect impacts to be imposed by the proposed duplication on native fauna or on habitats and resources as apply to native flora. Given the high levels of disturbance and environmental modification which pertain at this locality, and given the implementation of impact amelioration measures (as applied to the Brunswick Heads Bypass construction), the imposition of significant adverse indirect impacts on native fauna or their habitats is not regarded as likely.

Species of Conservation Significance

Four threatened fauna species, as listed under the TSC Act, were recorded in the vicinity of the proposed duplication during the surveys conducted for this assessment. A number of additional threatened fauna species were recorded during previous investigations for the Brunswick Heads Bypass in the general locality (Milledge & McKinley 1992). Those investigations determined the most appropriate route for the Brunswick Heads Bypass, in terms of minimising adverse impacts upon native fauna and flora, which is the option which was selected for the current Bypass.

No fauna species listed as threatened under the Commonwealth ESP Act have been recorded in the investigations conducted for the proposal. Similarly, no migratory birds as listed on JAMBA or CAMBA have been recorded along the Bypass duplication alignment, and there is no particularly relevant habitat for any such species in this locality. It is not considered likely that any fauna species of relevance under Commonwealth legislation or international treaties will be adversely affected by the proposal.

On the basis of the mobility of many of the threatened fauna species which were recorded by Milledge & McKinley (1992), it is considered likely that some individuals of several of these species could occur in habitat along the proposed duplication alignment, at least on occasions. Three of the threatened species recorded during this investigation are microchiropteran bats, which are wide-ranging and highly mobile. Furthermore, many of

the microchiropteran bats forage along forest boundaries or through modified woodland and forest communities. The Squirrel Glider is also a mobile arboreal mammal, with family groups occupying home ranges of 20 to 30ha. Given the limited area of vegetation which will be affected by the proposed duplication (Table 6.1), and the retention of substantial tracts of woodland and forest in this locality (Figure 7), it is not considered likely that the proposal will significantly affect these species.

Whilst there is not likely to be any "*significant effect*" imposed upon the microchiropteran bats, it is possible that the duplication could involve widening of the existing Bypass to the extent that the Squirrel Glider is not able to cross it (if it currently does so). Conversely, the width of the current alignment and the intensity of vehicular traffic are likely to prevent Squirrel Gliders from crossing the Bypass at present, and the proposed duplication will consequently not impose a further constraint to this species in this regard.

It cannot be considered likely that those threatened fauna species known to occur in this locality would be dependent upon those portions of the land which are to be affected by the proposed duplication to any significant extent. Nor is it likely that the conservation of any such species in the vicinity would require the retention of any habitat or resources in the areas to be affected. The impact amelioration measures for native fauna which were recommended by Milledge & McKinley (1992), and the conditions included in the Section 120 Licence obtained for the original Bypass, will also minimise the potential for adverse impacts to be imposed by the proposed duplication.

Section 5A Assessment of Significance

As noted above, those threatened fauna species which are known from the general vicinity (Milledge & McKinley 1992) are moderately or highly mobile, and could potentially occur in the area to be affected. Conversely, it cannot be considered likely that these species would frequent the area which will be affected by the duplication, given its proximity to the existing Bypass and current roadworks.

It is not likely that "*a significant effect*" will be imposed upon any threatened fauna species as a consequence of the proposed duplication, as there is no likelihood of "*a viable local population*" of any of these species being dependent on the habitats or resources present or being "*placed at risk of extinction*" as a consequence of the roadworks (Appendix 9). Furthermore, the area of potential or known habitat for these species which may be affected by the proposal is extremely small in both local and regional terms, involving less than one hectare of already modified vegetation (Figure 7). The "*removal or modification*" of habitat for these species is limited, and the proposal does not involve an increase in threats to these species or their habitats.

Given the nature and circumstances of the proposed duplication, and the characteristics of the fauna species which are known to occur in the general locality, it is considered that there is no likelihood of this element of the proposal imposing "*a significant effect*" on any threatened fauna species. Most of the species which are known from the general vicinity of the duplication have also been recorded from the Brunswick to Yelgun section of this proposal, however, and several species are considered under s.5A in Appendix 9.

There is no relevant "*endangered population*" or "*endangered ecological community*", as identified in the TSC Act, located in the vicinity of the proposed Brunswick Heads Bypass duplication.

6.4 BRUNSWICK to YELGUN UPGRADE - POTENTIAL IMPACTS

The northern portion of the proposal involves the construction of a dual carriageway, as well as the retention and in some locations the relocation of the existing highway as a local road. This element of the proposal will necessitate the clearing of native vegetation and habitats, the disturbance of resources and habitats of relevance for threatened and protected fauna and flora, and the imposition of an array of impacts at somewhat greater intensity than will be the case along the proposed Brunswick Heads Bypass duplication.

Conversely, the option which has been selected for the proposal (Route A2) involves disturbance to areas which are generally already somewhat modified or degraded, and the use of an existing disturbed corridor (as a result of the existing highway and of other clearing and development) rather than requiring disturbance of currently undisturbed or slightly disturbed landscapes. Thus, this section of the proposal involves an intensification of an existing activity rather than the imposition of a novel impact in the landscape.

Notwithstanding the levels of disturbance present along Route A2, however, there will be a range of impacts imposed upon the natural environment as a result of the activity. In general terms, those direct and indirect impacts which are discussed above (Section 6.1) will be imposed as a consequence of the proposed upgrade, although the location and design of Route A2 has limited the significance of the impacts which would otherwise be imposed.

By utilising Route A2, and by implementing the 'best practice' measures which are part of the activity (Section 7), the significance of the potential impacts which are likely to be imposed as a consequence of the proposal has been limited. Thus, selection of Route A2 has minimised the effects of the proposal in terms of habitat fragmentation, wildlife mortality and barrier formation. In addition, the design of the proposal has been specifically developed to minimise the area of vegetation which requires clearing, and to involve a range of construction and future management measures intended to minimise the potential for direct and indirect adverse impacts upon the natural environment.

6.4.1 Potential Impacts on Flora

General

As noted above, the proposed Brunswick to Yelgun upgrade of the Pacific Highway will require the removal of native vegetation along a substantial proportion of the route. Conversely, most of the area to be affected is disturbed or modified from its original condition, particularly as a result of weed-infestation from the existing infrastructure and other developments, clearing, horticultural plantings, grazing and various other activities.

As discussed above, the selection of Route A2 for the proposal was predicated in large measure on the ability to utilise areas characterised by existing disturbance, rather than involving areas of native vegetation in good condition. Nevertheless, the proposal will involve the removal of native vegetation and habitats for both threatened and protected flora species.

Species of Conservation Significance

Nine threatened plant species have been recorded from the this part of the proposed route, of which six species were recorded along the actual alignment, and are likely to be affected. A number of specimens of Stinking Cryptocarya, Davidson's Plum, Crystal Creek Walnut, Green-leaved Rose Walnut, Spiny Gardenia and Red Lilly Pilly (Table 4.4) appear to require removal for the construction of the proposed upgrade, although other individuals of each of these species are known to occur in the general vicinity and will be retained.

Furthermore, it is proposed in all instances to propagate individuals of relevant threatened species, to translocate individuals in some instances, and to utilise them in site rehabilitation works, landscaping and in rehabilitation of disturbed portions of the Nature Reserves (subject to negotiations with and the agreement of the NP&WS). This approach (as documented in Section 7 of this report) has been adopted to avoid the loss of genetic material or of populations of these threatened flora species, where individual plants can not be avoided by the proposal.

Those species listed as threatened under the TSC Act which are to be affected by the proposal are also listed on the Commonwealth ESP Act as nationally significant. There are no additional nationally threatened plant species of relevance to the proposal (*ie* listed in the ESP Act but not the TSC Act).

Several ROTAP species (Briggs & Leigh 1996) have also been identified along Route A2 for the proposed upgrade, as well as elsewhere throughout the general study area. As with

threatened plants, several of these species will be affected by the proposal, although other individuals of these plant species are known from the locality. The number of individuals which require removal is not regarded as of significance with respect to the conservation of those plant species.

Eleven plants regarded as of regional conservation significance were also recorded in the study area, and a few individuals of some of these species are likely to require removal for the proposal. Conversely, as is the case with the other plant species of conservation significance, there are substantial populations of these plant species which will not be affected by Route A2, and their conservation in the locality is considered unlikely to be compromised by the proposal.

The propagation of plants of conservation significance will be implemented as part of the activity (Section 7 of this report), and plants of regional conservation significance will be utilised in the rehabilitation of Nature Reserves in the immediate locality (where appropriate, and subject to agreement with the NP&WS).

Section 5A Assessment of Significance

Those threatened plant species recorded from the study area and which are to be affected by the proposal have been considered with respect to Section 5A of the EP&A Act, to determine "*whether there is likely to be a significant effect*" on any of these species or their habitats (Appendix 9).

Because of the uncertainty regarding the definition of "*viable local population*" (see Appendix 9), and some uncertainty regarding the precise location of the edges of clearing and construction activities required for the proposal in this section, a 'conservative' approach has been adopted with respect to the application of s.5A of the EP&A Act (Appendix 9). Thus, where an individual plant species has been recorded along the alignment and appears likely to require removal, this has been regarded as "*a viable local population*", and the potential effects of the proposal have been considered in detail under s.5A.

On this basis, application of s.5A to some of the threatened plants which occur along the proposed alignment indicates that the activity may involve the imposition of "*a significant effect*" on these species. Consequently, a Species Impact Statement (SIS) has been prepared for the activity.

6.4.2 Potential Impacts on Fauna

General

As discussed above, the proposal along Route A2 will involve the removal of some areas of native vegetation (Table 6.1; Figure 8), although most of the areas to be affected are moderately to highly disturbed as a result of weed-infestation, existing development and other disturbances.

Notwithstanding their disturbed and modified condition, however, the habitats, vegetation communities and features present in the area which will be affected by the proposal do provide resources and habitat features for protected and threatened native fauna. The clearing and removal of habitats and vegetation for the proposed upgrade will involve the removal of resources and features which are currently used by native fauna, and will, to a limited extent, reduce the available habitat for native fauna in this locality.

In this regard, the removal of areas of forest and woodland, particularly of rainforest, will involve some reduction in available vegetation and habitats for an array of threatened fauna and protected species. The construction of the Pacific Highway upgrade along Route A2 will clearly involve the removal of some native vegetation (Table 6.1). Several hectares of rainforest, of wet sclerophyll forest and of swamp sclerophyll forest occur within the Route A2 corridor, although not all of these communities within the corridor will require removal. Additionally, as indicated in Figure 8, substantial areas of most of the vegetation communities to be affected will be retained in the immediate vicinity, as well as throughout the locality. Species dependent upon these resources, and their habitats, will be affected by

the removal of vegetation for the upgrade, and to a limited extent by the alienation of habitats and resources in the immediate vicinity. Other habitats of relevance to be affected (albeit generally to a limited extent - Figure 8) include mangroves, riparian and riverine habitats, a few wetlands and grassland communities. Loss of habitat and resources from these areas will doubtless affect some individual protected, and possibly some threatened, fauna species.

Conversely, as noted above with respect to native flora, the preferred route was chosen largely on the basis of minimising the potential for adverse impacts upon native fauna (as well as flora), by utilising an existing disturbed corridor, rather than imposing novel impacts upon areas of habitat and vegetation which remain essentially intact. Thus, whilst the proposed upgrade will remove some habitat and resources for native fauna, these impacts are limited in extent (Figure 8), and will be offset by the provision of compensatory habitat elsewhere in the locality. In addition, rehabilitation of areas disturbed for the roadworks, as well as adjacent land, will compensate for the habitats and resources which will be removed.

Species of Conservation Significance

Several threatened fauna species have been recorded in the area between the Brunswick River and Yelgun, although no records were obtained from the proposed alignment. Nevertheless, as is the case for the proposed Bypass duplication, many of the threatened fauna species recorded in the area are moderately to highly mobile, and all of the species indicated in Table 6.2 are likely to occur along the alignment, at least on occasions.

As noted above, habitat and resources will be removed as a result of clearing operations required for the proposal, and it is likely that some features which may be utilised by threatened species, at least on occasions, will require removal. Conversely, it does not appear likely that the proposed activity will involve the removal or modification of habitat critical to the survival of any threatened fauna species. None of the species which have been recorded in the immediate vicinity are likely to be restricted to those areas which will be affected by the proposal.

Table 6.2 Threatened fauna species considered of relevance to the proposed Pacific Highway upgrade project at Brunswick Heads.

Common Name	Scientific Name	Recorded
Koala	*Phascolarctos cinereus*	✓
Squirrel Glider	*Petaurus norfolcensis*	
Queensland Blossom Bat	*Syconycteris australis*	✓
Little Bent-wing Bat	*Miniopterus australis*	✓
Wompoo Fruit-dove	*Ptilinopus magnificus*	
Osprey	*Pandion haliaetus*	✓
Eastern Long-eared Bat	*Nyctophilus bifax*	✓
Greater Broad-nosed Bat	*Scoteanax rueppellii*	
Bush-hen	*Amaurornis olivaceus*	
Pied Oystercatcher	*Haematopus longirostris*	✓
Sooty Oystercatcher	*Haematopus fuliginosus*	
Rose-crowned Fruit-dove	*Ptilinopus regina*	
Superb Fruit-dove	*Ptilinopus superbus*	
Collared Kingfisher	*Todiramphus chloris*	
Mangrove Honeyeater	*Lichenostomus fasciogularis*	

The species most likely to be affected to the greatest extent by the proposal include the Koala, the rainforest pigeons (fruit-doves) and a few of the microchiropteran bats. Conversely, given the levels of disturbance along the proposed alignment and the extent of engineering design and construction protocols, as well as the rehabilitation and compensatory habitat proposals which are associated with the activity, it is not considered

likely that the proposal will impose significant impacts upon threatened fauna species or their habitats.

The Brunswick to Yelgun upgrade of the Pacific Highway will involve the removal of some potential foraging habitat for Koalas, some patches of rainforest which are likely to be used for foraging by the rainforest pigeons, and forest and woodland communities utilised by microchiropteran bats. As indicated in Table 6.1, however, and as illustrated in Figure 8, only a small proportion of the relevant habitats and vegetation communities are to be removed for the proposal.

The potential for adverse indirect impacts to be imposed on the SEPP 14 wetlands has also been considered, and stringent protocols will be implemented during the construction phase to avoid the discharge of sediment or contaminants from roadworks into these wetlands. Water quality control measures are to be applied both during the construction and operational phases of the Highway, to minimise or avoid the potential for adverse impacts to be imposed upon these wetland communities. It should be noted that no specific measures have been implemented along the existing Pacific Highway to limit impacts upon these mangrove communities, but that nevertheless the extent of impacts appears to be limited to the fringes. Very small areas of mangrove and associated saline wetlands will also be affected by the proposed upgrade (0.2ha or less - Figure 8), potentially removing some (already disturbed) resources for the Mangrove Honeyeater and Collared Kingfisher.

For species such as the Koala and bandicoot species, the proposal involves the construction of safe underpasses (Chapter 7), enabling these species to cross the highway without being struck by motor vehicles. In this regard, the proposal will reduce the effects being imposed by the existing Pacific Highway.

For the other relatively to highly mobile species, the proposal will involve an array of measures, including compensatory habitat, to ensure that local populations of these species remain in the locality. Particular measures are to be applied along watercourses in the vicinity, notably the Brunswick and Marshall's Creek, to retain habitat for wetland bird species such as the Australasian and Black Bitterns and the Bush Hen (if they are present).

As noted above, no fauna species listed as threatened on the Commonwealth ESP Act have been recorded along Route A2 or in the field investigations for this proposal. Conversely, a few nationally threatened fauna species are known from the locality, although it is not considered likely that any such species will be adversely affected by the proposal.

Similarly, migratory birds listed on JAMBA and CAMBA are not regarded as likely to adversely affected, given the absence of appropriate habitat and/or the minimal disturbance to habitats (Table 6.1) and resources for these species which will arise as a result of the proposed roadworks.

Section 5A Assessment of Significance

As noted above, whilst there will be some removal of resources which may be utilised by threatened fauna species, the proposal involves a range of measures (including protection of habitat and resources, the provision of compensatory habitat, and rehabilitation and planting programs) to replace habitat and resources for threatened fauna.

Given the nature and circumstances of the proposal in this section, and the habitats and habits of the relevant threatened fauna species, the application of Section 5A of the EP&A Act (Appendix 9) indicates that the proposed activity will not impose "*a significant effect*" on any threatened fauna species "*or their habitats*". This circumstance arises because of the impact mitigation measures which have been incorporated into the activity, including the route selection process, engineering protocols and design, the rehabilitation program and provision of compensatory habitat.

Consequently, there is no requirement for a Species Impact Statement with respect to threatened fauna as a result of the proposal.

6.5 SEPP 14 - COASTAL WETLANDS

State Environmental Planning Policy No 14 - Coastal Wetlands (SEPP 14) aims "*to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the state*". SEPP 14 applies to land which is mapped as coastal wetland on a series of maps held by the Department of Urban Affairs & Planning (DUAP). It requires that any activity which involves the clearing, construction of a levy, draining or filling of coastal wetlands may only proceed with the consent of Council and the concurrence of the Director-General of DUAP.

The proposed duplication of the Brunswick Heads Bypass will not involve disturbance to any SEPP 14 mapped wetlands, and SEPP 14 does not apply to that section of the project. However, the proposed upgrade between the Brunswick River and Yelgun will involve some disturbance to two coastal wetlands, where the proposal crosses the Brunswick River.

SEPP 14 Coastal Wetland No 62 is located on the northern shore of the Brunswick River, west of the existing highway. A very small portion of the eastern extremity of this wetland where it abuts the existing highway (less than 0.3ha - of which part includes the existing Highway) will require clearing and filling for construction of the new road. This area of mangroves is already disturbed, and constitutes an insignificant portion of the mangrove communities in the locality (Figure 8).

Coastal Wetland No 65 is located on the southern shore of the Brunswick River, to the east of the existing highway. Because of the scale of mapping of SEPP 14 wetlands (1:25000), it is not clear whether Coastal Wetland No 65 will be directly affected (by clearing or filling) as a result of the proposal. If this wetland is to be affected, however, only a very small portion of the western extremity of the wetland will be modified by the proposal (Figure 8), involving less than 0.3ha.

The existing highway, north of Billinudgel, abuts another SEPP 14 Coastal Wetland (No 57). The proposal in this vicinity has been designed in a manner to avoid impinging upon the Billinudgel NR, which coincides at that location with the boundary of the SEPP 14 wetland. On this basis, the proposal will avoid Coastal Wetland No 57.

SEPP 14 requires development consent under the EP&A Act by local Council (Byron Shire Council) and the concurrence of the Director-General of DUAP. In addition, SEPP 14 notes that "*development for which consent is required by a Subclause (1) is declared to be designated development for the purposes of the Act*" (Clause 7(3) of SEPP 14). On this basis, it will be necessary to submit an application for development consent to Byron Shire Council in respect of the activities proposed in Coastal Wetlands No 62 and possibly No 65. In this regard, the EIS for the proposed Bypass duplication and proposed upgrade of the Pacific Highway at Brunswick Heads provides sufficient information to enable Council and the Director-General of DUAP to consider the proposal in the gazetted wetland areas.

With respect to the granting of concurrence to activities in SEPP 14 wetlands, a number of matters require consideration by the Director-General of DUAP, as delineated in Clause 7(2) of SEPP 14. Features of the SEPP 14 wetlands to be disturbed and of the proposed construction and operation of the proposal have been considered in the design and development of the project, and in the preparation of the EIS, including:

- the vegetation communities to be affected in both Wetland No 62 and No 65 are predominantly mangrove forest (as detailed in Section 3 of this report), with small patches or fringing areas of Swamp Oak *Casuarina glauca*;
- these vegetation communities provide resources for a number of native fauna species, although only a limited number of species are capable of using mangrove forest communities;
- both wetlands are entirely or largely tidal, and are thus characterised by high salinity, except during flooding of the Brunswick River and (for Coastal Wetland No 62, at least) during high rainfall events and subsequent freshwater discharge from the existing highway;
- only a very small area of the mangrove and Swamp Oak communities will be removed for the proposal, confined to the eastern extremity of Coastal Wetland No 62 and possibly the western extremity of Coastal Wetland No 65;

- in the case of Coastal Wetland No 62, the area to be affected by roadworks constitutes only an extremely small proportion of that Coastal Wetland, involving less than 0.3ha (Figure 8);
- in the case of Coastal Wetland No 65, it is not clear that any removal of wetland vegetation will be required. Any clearing or other activities in Coastal Wetland No 65 will involve only a minute proportion of that wetland, probably amounting to no more than 0.3ha;
- the areas of Coastal Wetlands No 62 and No 65 which will or might be cleared for the proposal, in addition to being of extremely small extent, are already partially disturbed by the existing highway and/or by recreational activities. Existing disturbances include human access, discharges from the existing highway, partial clearing (for boat access), and some littering and weed encroachment; and
- the loss of habitat for native fauna is not of particular relevance in local or regional conservation terms, given the minute extent of coastal wetland communities and resources which are to be removed, and the extent of these habitats and resources to be retained in the locality.
- the design, construction and management of water quality control measures, both during the construction phase and in the long-term, to avoid or minimise the discharge of sediment, contaminants or poor quality water from roadworks and from the completed roads into SEPP 14 Wetlands; and

A number of other matters have been considered in the design, location and the ultimate construction and operation of the proposed upgrade at the Brunswick River, which are of relevance in the consideration by the Director-General of DUAP as to whether concurrence should be granted to development consent, and of relevance to Byron Shire Council in determining the Development Application. Of particular relevance are design features of the proposal in this locality, including:

- the exhaustive route selection process for the proposed upgrade, which concluded with selection of Route A2 as the preferred route. Whilst this option involves some minimal clearing of Coastal Wetland No 62 and possibly of Coastal Wetland No 65, it does so in an area where these wetlands are already affected by human activities (*ie* the edges of these communities), as well as avoiding the potential for more extensive clearing in coastal wetlands to the west, which may have occurred had one of the other route options been selected. In this regard, the LEP-zoned area for the highway upgrade (to the west of the current highway location) would have required a substantially greater area of clearing of Coastal Wetland No 62 than is required for Route A2. Other route options to the west, although in most instances avoiding designated coastal wetlands, would also have required substantially greater clearing of mangrove forest or other wetland communities than will be required for Route A2;
- the extremely sensitive and controlled design criteria which will be applied to the construction of the proposal, involving a minimum cross-section, the use of complex design characteristics, and the use of vertical engineered retaining walls rather than battered slopes, to minimise the footprint of the road;
- the design, construction and management of water quality control measures, both during the construction phase and in the long-term, to avoid or minimise the discharge of contaminants or poor quality water from roadworks and from the completed roads into SEPP 14 Wetlands; and
- the establishment of construction protocols which require that all construction activities be confined to the proposed road corridor, and that construction activities, personnel and vehicles be required to remain within the road corridor and not operate from beyond it. This approach is adopted to ensure that vegetation clearing will be confined to the absolute minimum necessary.

Additionally, areas of Brunswick River bank which are currently disturbed will be rehabilitated to mangrove vegetation (*eg* where the existing highway bridge is to be

removed). The new bridge design also allows for rehabilitation and replanting of mangroves, and rehabilitation and enhancement of mangroves in the immediate vicinity of the proposed road corridor can also be accommodated.

Given the above considerations, the proposal (as located along Route A2 and as defined and detailed in the EIS for this project) is considered the most appropriate option with regard to its potential impacts upon coastal wetlands. The approach which has been adopted for this project involves restricting the clearing of coastal wetland communities to the minimum possible, affecting already partially disturbed wetland communities, and the implementation of design criteria and construction protocols intended to minimise the potential for any adverse impacts. The proposal has appropriately considered the options available.

Given the considerations detailed above, the proposed upgrade of the Pacific Highway at Brunswick Heads adequately addresses the aims of SEPP 14.

6.6 SEPP 26 - LITTORAL RAINFOREST

The aim of *State Environmental Planning Policy No 26 - Littoral Rainforests* (SEPP 26) "*is to provide a mechanism for the consideration of applications for development that is likely to damage or destroy Littoral Rainforest areas with a view to the preservation of those areas in their natural state*". SEPP 26 requires consent from Council for almost any activity which is to be conducted on land which has been mapped as Littoral Rainforest, and on land within 100 metres of vegetation so mapped.

SEPP 26 states, in Clause 4, that the policy applies to:

"*(a) land enclosed by the outer edge of the heavy black line on the series of maps held in the Department and marked "State Environmental Planning Policy No. 26 - Littoral Rainforests (Amendment No. 1)"*; and

(b) land not so enclosed but within a distance of 100 metres from the outer edge of that heavy black line except residential land and land to which State Environmental Planning Policy No. 14 - Coastal Wetlands applies".

The nearest portion of Littoral Rainforest, as mapped under SEPP 26, to the proposed upgrade and proposed duplication of the Pacific Highway at Brunswick Heads is SEPP 26 Littoral Rainforest No 18. This stand of Littoral Rainforest is located approximately 300 metres to the east of the proposed alignment, where the upgrade of the Pacific Highway crosses the northern shoreline of the Brunswick River. As the vegetation through which the proposed upgrade does not constitute SEPP 26 Littoral Rainforest, and the road is located in excess of 100 metres from that mapped rainforest, and there are no other portions of Littoral Rainforest in closer proximity to the proposal, SEPP 26 does not apply to the proposal.

Notwithstanding that SEPP 26 does not apply, the proposal has been specifically designed and located, and will be constructed and maintained, in a manner which minimises the potential for adverse impacts being imposed upon the natural environment in general, and on rainforests in particular. Considerable effort has been dedicated to providing an engineering design and to locating the proposed upgrade on the northern side of the Brunswick River to limit the clearing of vegetation to the absolute minimum necessary.

6.7 SEPP 44 - KOALA HABITAT PROTECTION

State Environmental Planning Policy No 44 - Koala Habitat Protection (SEPP 44) has, as its aims and objectives, the encouragement of "*the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline:*

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat; and

(b) *by encouraging the identification of areas of core koala habitat; and*

(c) *by encouraging the inclusion of areas of core koala habitat in environment protection zones*".

SEPP 44 requires an assessment of whether land to which the SEPP applies is "*potential koala habitat*" or "*core koala habitat*". However, Clause 6 of SEPP 44 states that Part 2 - Development Control of Koala Habitats of the SEPP applies only to land "*in relation to which a development application has been made*", and under certain circumstances. The proposal does not involve the making of a Development Application, except with respect to the clearing of vegetation in SEPP 14 - Coastal Wetlands. With these exceptions, Part 2 of SEPP 44 does not therefore apply to the activity.

Those areas of the alignment which are of relevance (the SEPP 14 Wetland areas) do not support tree species of relevance to SEPP 14, and no positions of the proposal constitute "*potential koala habitat*". Furthermore, Part 3 - Plans of Management and Part 4 - Other Environment Planning Measures also do not apply to the proposed activity.

Whilst SEPP 44 does not apply to most of the proposal, and there is no "*core koala habitat*" along the alignment, the presence of Koalas in the vicinity has been acknowledged in the EIS. Appropriate measures to ensure the conservation of this species in the vicinity, both through the construction phase and in the subsequent operation of the proposal, have been incorporated into the project.

6.8 Brunswick Heads and Billinudgel Nature Reserves

As discussed elsewhere in this report, the proposal has been located and designed to minimise impacts upon the Brunswick Heads and Billinudgel Nature Reserves. At the northern end of the proposal, tight design and engineering constraints have been applied to ensure that roadworks do not require any removal of resources or habitat from the Billinudgel NR itself. Furthermore, construction protocols are to be applied at this locality to ensure that indirect effects on the Nature Reserve (such as sediment or contaminant discharge, or significant alterations to hydrologic regimes) are not imposed upon the Nature Reserve and the vegetation within it.

Where Route A2 passes through the Brunswick Heads NR (north of the Brunswick River), specific design features for the new road have been incorporated into the project, so that maximal use is made of the existing Pacific Highway corridor. The proposal requires the removal of a small portion (approximately 0.3ha) of the western end of the eastern part of the Brunswick Heads Nature Reserve (Figure 8). It should be noted, however, that this portion of the Nature Reserve is mostly highly modified and degraded, and includes part of an old quarry, an access road and carparking area, a weed-infested slope from the existing Pacific Highway, and only small areas of relatively undisturbed native vegetation. Stringent design measures have been implemented at this location to minimise the area of vegetation and Nature Reserve which require removal.

Similarly, the proposal will require the removal of a small part of the Brunswick Heads NR to the west of the existing Pacific Highway. The proposal has been specifically designed so that only a narrow strip of the Nature Reserve to the west of the Pacific Highway will require removal (involving about 0.29ha). Most of this portion of the Brunswick Heads NR is already weed-infested as a result of the existing road construction. Thus, whilst there will again be some direct loss of Nature Reserve land and of vegetation as a result of the proposal, specific design features have been incorporated into the roadworks to minimise the area to be affected and to focus on portions of the Nature Reserve which are already disturbed.

Other impact amelioration measures are to be applied at the Brunswick Heads and Billinudgel Nature Reserves, as detailed in Section 7 of this report, to minimise the potential for adverse impacts being imposed. Additionally, the provision of compensatory habitat is intended to offset the minor impacts which will be imposed on the Nature Reserves by the proposal.

7 IMPACT AMELIORATION

As discussed in Section 5 of this report, the proposal has been located and incorporates a substantial array of design features specifically included and intended to mitigate the potential for adverse impacts on the natural environment as a result of the activity. In this regard, the selection of Route A2 as the preferred route has involved considerable assessment of potential alternative routes for the upgrade, and was based to a substantial degree on minimising the potential for adverse impacts on the natural and physical environment. Furthermore, the final concept design and associated features have been specifically designed to mitigate the potential for adverse impacts during construction and operational phases of the road.

Similarly, duplication of the Brunswick Heads Bypass, by the addition of a second carriageway immediately adjacent to it, minimises the necessity for additional clearing of native vegetation. Thus, the project has already involved a process which minimises the potential for adverse impacts.

Particular measures of relevance in this regard include:

- location of the southern interchange, and access ramps and roads to it, to avoid the saltmarsh south of the Brunswick River;
- the application of specific design and engineering criteria to the new road between the southern interchange and the access road to the sewage treatment plant, so as to limit the extent of vegetation clearing required in the Brunswick Heads NR and near vicinity to the absolute minimum possible;
- the incorporation of engineered vertical retaining walls and a minimum cross-section where the proposed road corridor abuts the Brunswick Heads and Billinudgel NRs, to avoid any significant removal of vegetation;
- the incorporation of extended bridge structures at the Brunswick River and at Marshall's Creek, to provide adequate fauna movement opportunities along these watercourses; and
- the implementation of construction protocols which would require no disturbance beyond the actual road alignment at areas of significance (particularly at the Brunswick Heads and Billinudgel NRs).

In addition to the mitigation of potential impacts by the careful selection and appropriate design of the proposal, a range of general environmental management (impact amelioration) measures are to be applied (involving appropriate measures and protocols during the construction phase, water quality control measures and general environmental protection) and a number of specific measures are also incorporated into the project. Specific environmental management measures are included for threatened species (particularly threatened plants), the Nature Reserves, SEPP 14 wetlands and for native fauna (as detailed below).

A commitment to environmentally sensitive development is inherent in the location and design of the proposal. As noted above, a range of measures have been employed to mitigate the potential for adverse impacts to be imposed by the roadworks, thus reducing the impacts which could theoretically arise from the roadworks. Thus, the activity has, by its very design, already reduced the potential adverse impacts which could be imposed upon the natural environment.

Furthermore, the impact amelioration and environmental management measures which are included in this section of this report are regarded as integral parts of the activity. These environmental management measures constitute actions which are to be implemented to avoid or minimise the potential for adverse impacts to be imposed by the activity, rather than as responses to actual impacts which are to be imposed. Thus, in most instances, the measures constitute impact avoidance, rather than impact amelioration, and have consequently been described within this section as environmental management measures.

7.1 GENERAL IMPACT AMELIORATION

A range of general environmental management (impact amelioration) measures are included as part of the proposal and contribute to the avoidance of or minimisation of potential adverse impacts on native fauna and flora. The general measures to be implemented along the proposal include:

- the minimisation of vegetation clearing at all locations, limiting that removal to the minimum necessary for the road's construction;
- 'best practice' management of erosion and sediment discharge during the construction phase, to ensure that there is no significant discharge of sediment into watercourses or vegetation communities downslope and downstream of the roadworks. A range of measures is to be implemented during construction, including the use of silt fences, sediment ponds, hay bales and the covering and protection of exposed soil surfaces as rapidly as possible (AS described in the Water Quality Working Papers and the EIS);
- minimising or avoiding disturbance to acid sulphate soils, to prevent the potential for adverse impacts to be imposed on habitats or species downslope or downstream. This consideration is of particular relevance in the vicinity of the Brunswick River;
- the construction and use of water quality control ponds, incorporating macrophyte vegetation, to ensure that the water quality of adjacent watercourses and water bodies does not deteriorate as a consequence of discharges from the construction and operational phases of the proposed road;
- the implementation of an intensive and extensive rehabilitation and replanting program along the road, involving the use of indigenous native species;
- the collection and propagation of seed and fruit from native plant species cleared along the full length of the proposal, for their utilisation in replanting and rehabilitation projects in the vicinity, and on landscaping along the alignment. Additionally, native plant material should be collected and chipped, to be used as a mulch and groundcover in landscaping and rehabilitation areas, to promote the regrowth of native and endemic plant species;
- the retention of topsoil, where possible, and its use on areas of landscaping and rehabilitation in the immediate vicinity of the roadworks. In addition to retaining the native seedbank in the soil, the use of existing topsoil from the locality in rehabilitation will retain tubers, bulbs and other vegetative material from which native plants can regenerate, and will also provide the microbial and microrhizzal biota which are of relevance in the establishment and maintenance of native vegetation;
- the propagation and planting of plant species of conservation significance as advised and directed by the NP&WS;
- the location of all works sites, stockpile areas, storage facilities and vehicle parking and maintenance areas on already disturbed land, avoiding any necessity for the clearing of vegetation for these activities;
- the avoidance of any stockpiling of materials or parking of vehicles, or other unnecessary disturbance, beneath vegetation and trees which are to be retained along the alignment; and
- the management of general construction activities along the alignment to ensure the appropriate disposal of rubbish and general waste materials, to prevent the loss or discharge of waste into remnant vegetation, the collection and removal of excess contaminants, the bunding of potential liquid contaminants, and the provision of appropriate ablution and work-shed facilities to prevent the discharge of contaminants into native vegetation.

7.2 BRUNSWICK HEADS BYPASS DUPLICATION - SPECIFIC MEASURES

To a considerable extent, the impact amelioration measures of particular relevance for native fauna and flora along the proposed duplication simply involve an extension and continuation of those measures applied to the construction of the first carriageway, as recommended by Milledge & McKinley (1992) and included in the Environmental Management Plan (EMP) for that portion of the project (Kinhill 1996).

Measures such as the installation of culverts for fauna, the use of fauna fencing, the construction and management of wetlands and the rehabilitation program are to be extended for the duplication project. With respect to the implementation of measures for the safe crossing of the road by fauna, an ongoing monitoring program to confirm the efficacy of measures applied at this locality is also recommended.

Specific impact amelioration measures which are part of the proposed activity along the Brunswick Heads Bypass duplication, consistent with those previously recommended for the portion of the Bypass already constructed, include:

- extension of the culverts and fauna underpasses located along this section, to continue to provide safe movement opportunities for fauna beneath the roadway;
- relevant treatments in the fauna underpasses and at each end should be applied, including the placement of rocks and logs (within the underpass and at its entrance), the planting of appropriate native vegetation and the provision of a dry path for fauna to use;
- extension of the use of fauna fencing, including 'floppy-top' fencing for Koalas as has been constructed for the first carriageway;
- the use native and endemic plant species and propagules for rehabilitation and habitat planting along the Bypass duplication, as detailed in the EMP for the first carriageway;
- consideration of the provision of stags (derived from trees felled for the Bypass duplication project) or the retention of existing trees at appropriate locations within the central nature strip between the two carriageways (and protected by safety fencing) to enable gliding species (such as the Squirrel Glider) to traverse the widened roadway, if they so desire; and
- implementation of a monitoring program, as recommended in the EMP for the existing bypass (Kinhill 1996).

One specific additional impact amelioration measure is proposed, relating to the Burny Bean *Mucuna gigantea* which is located near the southern end of the Bypass duplication. At this location, it appears likely that a proportion (at least) of that population will be removed for the duplication, and a series of protocols is proposed, including:

- the collection of seed from the population, including from those plants which are to be removed, and the collection of cuttings or root stock (if appropriate);
- propagation of plant material and seedlings, and the introduction of the species into appropriate habitat in the vicinity (*eg* in land to be conserved to the east of the Bypass); and
- the collection of ecological and morphological information from the population and from those individuals to be removed, to provide an increased information base regarding this species.

7.3 BRUNSWICK to YELGUN UPGRADE - SPECIFIC MEASURES

In addition to the general measures for protection of the environment discussed above, a number of specific environmental management measures are proposed. These measures are part of the proposal, and will have the effect of ameliorating impacts which could potentially apply in their absence. Particular measures are to be applied with respect to the SEPP 14 wetlands, the saltmarsh vegetation, the Brunswick Heads and Billinudgel NRs, native flora and fauna (particularly threatened species).

SEPP 14 Wetlands

In addition to the specific features which have been incorporated into the design to limit the area of wetland vegetation to be affected, specific protocols are to be applied during the construction phase and as part of the long-term management of the road to protect these vegetation communities. These measures also apply to other wetlands and watercourses along the alignment (*ie* those not protected under SEPP 14), and include:

- a construction protocol which requires that all earthworks, machinery and personnel be restricted to the upgrade alignment footprint and one metre beyond it. No machinery or personnel are to be permitted beyond that area without the approval of the Project Manager (RTA);
- stringent application of erosion and sediment discharge control measures, to avoid sediment discharge into retained wetlands and wetland vegetation communities;
- implementation of a weed removal, control and management program, to remove weeds from wetland areas adjacent to the roadworks, thus enhancing the habitat in these areas. Weed control programs are also required to avoid the introduction of new weeds or infestations in the vicinity;
- the removal of litter and rubbish from areas adjacent to the roadworks; and
- the implementation of a rehabilitation and replanting program to enhance the adjacent wetlands, and to ensure that wetlands do not become degraded or weed-infested in the long term.

These measures are particularly to apply to:

- the salt marsh and associated Casuarina swamp forest south of the Brunswick River and the existing highway;
- SEPP 14 Wetland No 65, on the southern shores of the Brunswick River and east of the proposed upgrade alignment;
- SEPP 14 Wetland No 62, located on the northern shores of the Brunswick River and west of the proposed alignment;
- Marshall's Creek; and
- SEPP 14 Wetland No 57, east of the proposed alignment near Billinudgel.

Detailed documentation of the measures to be applied at these locations will be included in the construction EMP.

Saltmarsh

Environmental management of the proposal with respect to the saltmarsh on the southern side of the Brunswick River (south of the existing highway) will essentially involve avoiding direct or indirect damage to the saltmarsh, and appropriate management of water discharges from the construction and operation of the proposed upgrade.

Particular measures with regard to the saltmarsh will include:

- strict and stringent application of erosion and sediment control measures and water quality management measures, to ensure that the saltmarsh is not affected by sediment, contaminants or excessive stormwater during the construction phase of the project;
- implementation of an appropriate rehabilitation and replanting program, to ensure that the saltmarsh is protected in the long-term;
- implementation of a weed removal, control and management program, specifically designed for the saltmarsh, to enhance the local environment and the vegetation community in particular; and
- the design and implementation of an appropriate water quality control and stormwater management program, to ensure that any discharges which arise

from the road system are of an appropriate quantity and quality in the long-term.

Brunswick Heads and Billinudgel Nature Reserves

Similar protocols and environmental management measures are to be implemented where the proposed upgrade abuts the Brunswick Heads and Billinudgel NRs as will apply at the SEPP 14 wetland sites. In this regard, stringent application of the erosion and sediment control measures, water quality and stormwater discharge measures, and minimisation of vegetation clearing protocols will apply, as will the implementation of long-term habitat enhancement and rehabilitation programs.

It should be noted that the proposal has been designed so as to avoid any direct impacts on the Billinudgel Nature Reserve. No clearing or construction activities are to occur in the Nature Reserve, and stringent measures are to be applied (as detailed below) to avoid the imposition of any indirect impacts upon Billinudgel NR.

Particular measures to be applied at the Brunswick Heads and Billinudgel NR sites include:

- the collection of propagules of threatened, ROTAP and regionally significant plant species which are to be removed prior to any clearing operations, and their propagation for use in rehabilitation and replanting programs as directed by the NP&WS;
- the collection and destruction of all weed material from the roadworks area and adjacent portions of the Nature Reserve (under the supervision of the NP&WS);
- the collection and shredding of all of native plant material and its redistribution into the Nature Reserves or other appropriate areas of native vegetation, as directed by the NP&WS;
- a pre-clearing inspection of all vegetation in the vicinity, to avoid adverse impacts upon native fauna species (as documented below);
- the implementation of a rehabilitation and replanting program, utilising appropriate plant species (including hardy plant species adjacent to the roadworks to provide protection for the rainforest, and plants of conservation significance as recommended by the NP&WS); and
- the implementation of stringent construction protocols, limiting the extent of clearing within the Nature Reserves to the absolute minimum possible. Specific engineering measures will include the use of vertical retaining walls rather than batters, the restriction of activities to within the road alignment itself, and the retaining of all discharges within the alignment.

Flora

As noted above, several specific environment management measures are to be implemented with respect to native vegetation, including (in all locations) minimisation of vegetation removal to the absolute minimum required for the project. Specific measures to be applied along the project with respect to plants of conservation significance will include:

- the avoidance of individual plants wherever possible, by the use of appropriate structures and design to enable individual plants to be retained;
- the appropriate design of wetlands and stormwater discharge points along the roadway, to avoid plants of conservation significance being affected by alterations in drainage and water discharge;
- the treatment of water derived from the construction and operation of the road to avoid the discharge of contaminants or nutrients onto plant species of conservation significance or into their habitats;
- the collection and subsequent relocation of individual plants of conservation significance where appropriate (depending on the individual species and as

advised by the NP&WS) where it is not possible to avoid them in the clearing and construction phases of the project;

- a comprehensive and detailed inspection of areas which are to be cleared or disturbed for the roadworks, to identify and ultimately to collect or protect any individual threatened plant species present;
- the collection of seeds or plant material from individual plant species of conservation significance (where appropriate) which are to be affected, and their propagation (Appendix 8) for use in replanting and rehabilitation programs (along the alignment or in relevant reserves, as advised by the NP&WS);
- the implementation of specific maintenance measures for propagated seedlings of threatened plant species, as part of the rehabilitation and management program for the proposal;

  the protection and management of plant species of conservation significance which are to be retained along the alignment during construction. Protective fencing, maintenance and monitoring, signage, and education of construction workers should be implemented at appropriate locations; and
- contribution by the RTA to the establishment of areas of compensatory habitat as a means of offsetting environmental impacts imposed by the proposal.

Fauna

A range of special measures are proposed to address specific issues of relevance for native fauna. In addition to the general measures proposed for the environmental management of the project, a number of specific measures and protocols are to be implemented.

Specific measures and protocols of relevance to threatened fauna species which will apply include:

- the conduct of pre-clearing surveys of native vegetation, wherever required, to identify individuals, fauna species or populations which require collection and relocation;
- specific searches for fauna of particular concern immediately prior to clearing activities, with particular attention paid to Koalas, the Queensland Blossom Bat, nests, large hollow-bearing trees and hollow-dwelling species. Measures to deal with fauna located prior to clearing will be included in the EMP;
- the retention of habitat features and resources for native fauna (such as hollow-bearing trees, hollow logs *etc*) wherever possible, particularly in areas of native vegetation of conservation value which are to be retained;
- consideration of the provision of stags (derived from trees felled for the Bypass duplication project) or the retention of existing trees at appropriate locations within the central nature strip between the two carriageways (and protected by safety fencing) to enable gliding species (such as the Squirrel Glider) to traverse the widened roadway, if they so desire; and
- re-use of elements of potential value for native fauna (such as hollow-bearing trees, hollow logs, rocks *etc*) in suitable areas (possibly including the Brunswick Heads and Billinudgel NRs, if deemed appropriate by the NP&WS);
- installation of fauna-proof fencing (particularly designed for terrestrial fauna and Koalas) to limit the opportunities for animals to gain access to the new highway. Fauna-proof fencing should be installed at sites where fauna underpasses or bridges designed for fauna movements are located, including:
  - the Brunswick River;
  - Marshall's Creek;
  - the Billinudgel Nature Reserve at Yelgun;

- the use of extended bridge structures at the Brunswick River and Marshall's Creek (retaining a section of watercourse banks), and appropriate contouring of the River and Creek banks, to provide fauna movement underpasses at these localities. In both instances, the use of appropriate vegetation planting, rocks and logs, and other features to encourage native species to utilise the underpasses and to provide protection from feral predators will be required. Additionally, sections of the underpasses should be raised so that fauna movements can continue during periods of moderate streamflow; and
- the maintenance of communication with the local NP&WS officers, WIRES and/or other relevant local wildlife carer groups, to deal with individual animals during the construction phase of the project.

Compensatory Habitat

The RTA has indicated a willingness with respect to this proposal (and in other road projects through NSW) to consider the provision of compensatory habitat to offset the loss of habitat and resources along road alignments. Compensatory habitat can be located at some distance from the alignment, and should be determined on the basis of habitat value and the potential to contribute to conservation goals, rather than being determined on the basis of proximity to the area of disturbance.

In this regard, the RTA will liaise with the NP&WS to identify suitable areas of vegetation and habitat presently owned by the RTA or which could be acquired by it. The RTA will also negotiate with the NP&WS regarding the appropriate mechanisms for the transfer of lands into the NP&WS estate or for other long-term management of lands for conservation purposes.

One appropriate measure with respect to compensatory habitat could involve the transfer of the land which is currently zoned in LEP 1998 for road purposes to the NP&WS, providing compensatory habitat (including mangroves, salt marsh and swamp oak forest) to replace that which is to be removed in the Brunswick Heads Nature Reserve and south of the Brunswick River.

8 BIBLIOGRAPHY

Adam P. 1981. Australian Saltmarshes. *Wetlands (Australia)* **1**: 8-10.

Allison FR & Hoye GA. 1995. Eastern Freetail-bat *Mormopterus norfolkensis*. In R Strahan (*ed*). *The Mammals of Australia*. p484-485. Australian Museum/Reed Books.

Andrew DL & Settle GL. 1982. Observations on the Behaviour of Species of Planigale (Dasyuridae Marsupialia) with particular reference to the Narrow-nosed Planigale *Planigale tenuirostris*. In Archer M (*ed*). *Carnivorous Marsupials*. Vol 1 p311-324. Royal Zoological Society of NSW, Mosman.

Andrews A. 1990. Fragmentation of habitat by roads and utility corridors: A review. *Aust Zool* **26**: 130-141.

ANZECC. 1992. *Basis for a National Agreement on Environmental Impact Assessment*. Australian & New Zealand Environment & Conservation Council. Australian Government Printing Service.

Archer M. 1976. Revision of the Marsupial genus *Planigale* (Troughton Dasyuridae). *Memoirs of the Queensland Museum* **17(3)**: 341-65.

Barry S & Thomas G. 1994. *Threatened Vascular Rainforest Plants of South eastern Queensland: a conservation review*. Unpublished report to Australian Conservation Agency Endangered Species Program from the Queensland Department of Environment and Heritage, Brisbane.

Baverstock P & Chambers M. 1992. *Murwillumbah Bat Survey*. Report prepared for the Forestry Commission of NSW.

Beadle NCW. 1971 - 87. *Students Flora of North Eastern New South Wales*. University of New England, Armidale.

Beadle NCW. 1981. *The Vegetation of Australia*. Cambridge University Press, Cambridge.

Bell H. 1960. Stray Feathers. *The Emu* **60:** 65.

Bennett A. 1993. Microhabitat use by the Long-nosed Potoroo, *Potorous tridactylus*, and other small mammals in remnant forest vegetation of south-western Victoria. *Wildlife Research* **20**: 267-85.

Benwell AS. 1997a. *Preliminary Flora Survey: Brunswick River west to Vallences Road and Coolamon Scenic Drive*. Unpublished Report to Gunninah Environmental Consultants, Crows Nest.

Benwell AS. 1997b. *Preliminary Flora Survey: Hilans Corner and Northeasterly Ridge*. Unpublished Report to Gunninah Environmental Consultants, Crows Nest.

Benwell AS. 1997c. *Preliminary Flora Survey: Proposed Route A2 Brunswick River to Yelgun Highway Upgrade*. Unpublished Report to Gunninah Environmental Consultants, Crows Nest.

Benwell AS. 1997d. *Flora Survey: Proposed Upgrade of the Pacific Highway, Brunswick River to Yelgun*. Unpublished report to Gunninah Environmental Consultants, Crows Nest.

Benwell AS. 1997e. *Flora Survey: Proposed Duplication of the Brunswick Heads Bypass*. Unpublished report to Gunninah Environmental Consultants, Crows Nest.

Blakers M, Davies SJJF & Reilly PN. 1984. *The Atlas of Australian Birds*. Royal Australasian Ornithologists Union. Melbourne University Press.

Boles WE. 1976. The 'rediscovery' of the first record of the Bush-hen for Australia. *Australian Birds* **11**:21-25.

Braithwaite RW. 1995. Brown Antechinus *Antechinus stuartii*. In R Strahan (*ed*). *The Mammals of Australia*. p94-7. Australian Museum/Reed Books, Chatswood.

Briggs JD & Leigh JH. 1996. *Rare or Threatened Australian Plants*. CSIRO, Canberra.

Briggs JD & Leigh JH. 1992. *Threatened Australian Plants*. Overview and Case Studies. CSIRO, Canberra.

BSPC. 1996. *Local Environmental Study: Environmentally Sensitive Lands, North Ocean Shores.* Balanced Systems Planning Consultants, Bangalow.

Calaby LH. 1995. Red-necked Wallaby *Macropus rufogriseus.* In R Strahan (*ed*). *The Mammals of Australia.* p350-2. Australian Museum/Reed Books, Chatswood.

Cathcart S. 1991. *Wildlife Survey of the Vertebrate Fauna of Brunswick Heads Nature Reserve, NSW.* University of New England, Northern Rivers.

Clancy G. 1991. *The Biology and Management of the Osprey (Pandion haliaetus cristatus) in NSW.* NP&WS, Hurstville.

Cogger HG. 1992. *Reptiles and Amphibians of Australia.* AH and AW Reed, Sydney.

Covacevich J & Archer M. 1975. The Distribution of the Cane Toad *Bufo marinus* in Australia and its effects on indigenous vertebrates. *Memoirs of the Queensland Museum* **17(2)**: 305-10.

Craven J. 1992. *Brunswick Heads Bypass. Vertebrate Fauna Survey.* NSW National Parks & Wildlife Service.

Cropper S. 1993. *Management of Endangered Plants.* CSIRO, Victoria.

CSIRO. 1996. *Fauna Survey Report for the Murwillumbah Management Area.* State Forests of New South Wales, Sydney.

Dames & Moore. 1996. *Creation of Little Tern and Wading Bird Habitat Towra Spit Island.* Dames & Moore, Botany Bay.

Davey SM. 1984. Habitat preferences of arboreal marsupials within a coastal forest in southern New South Wales. Pp 509-516. In Smith A and Hume I (*eds*). *Possums and Gliders.* Surrey Beatty & Sons, Sydney.

Date EM & Recher HF. 1989. *Ecology and Management of Rainforest Pigeons in New South Wales: Interim Report and Recommendations.* Unpublished report to the NSW National Parks & Wildlife Service.

Debus SJS & Chafer CJ. 1994. The Powerful Owl *Ninox strenua* in NSW. *Australian Birds* **28**: 21-38.

Debus SJS & Czechura GV. 1989. The Square-tailed Kite *Lophoictinia isura*: A review. *Aust Bird Watcher* **13**: 80-97.

Debus SJS & Rose AB. 1994. The Masked Owl *Tyto novaehollandiae* in NSW. *Australian Birds* **28**: 40-64.

Debus SJS. 1994. *Survey of Endangered Birds and Arboreal Mammals, and Management of the Osprey, at the North Bonville Development Site.* Prepared for Gunninah Environmental Consultants, Crows Nest.

Department of Arts, Sport, the Environment & Territories. 1992. *Nomination of Central Eastern Rainforests of Australia for inclusion on the World Heritage List.* Unpublished Report, Australian Government.

Department of Environment & Territories. 1995. *National Forest Conservation Reserves: Commonwealth Proposed Criteria.* Australian Government Publishing Service, Canberra.

DeVries R. 1997. *Vascular Plant Taxa of Priority Conservation Concern within North-eastern New South Wales.* Flora report No 4 of the Forest Biota Response to Disturbance Project in North-Eastern NSW. Unpublished Draft Report prepared by the NSW NP&WS Northern Zone, as part of the Comprehensive Regional Assessment of NSW Forests.

DL&WC. 1997. *Assessment of Crown Lands. Brunswick Heads.* Department of Land & Water Conservation, North Coast region.

Dwyer PD. 1995. Little Bentwing-bat *Miniopterus australis.* In R Strahan (*ed*). *The Mammals of Australia.* p492-493. Australian Museum/Reed Books, Chatswood.

Ecos Environmental Consultants. 1997. *Preliminary Flora and Fauna Survey and Statement of Environmental Effects for a Proposed Dwelling on Lot 2 Old New Brighton Rd, Byron Shire.*

Ehmann H. 1997. Wallum Sedgefrog. Pp 183-88 in Ehmann H (*ed*). *Threatened Frogs of New South Wales: Habitat, Status and Conservation.* Frog & Tadpole Study Group of NSW Inc, Sydney South.

Fanning FD. 1992. *Koala Road Deaths: Causes and Measures.* Gunninah Environmental Consultants, Crows Nest.

FCNSW. 1989. *Forest Types in New South Wales.* Research Note No 17. Forestry Commission of New South Wales, Sydney.

Floyd A. 1989. *Rainforest Trees of Mainland South-eastern Australia.* Forestry Commission of NSW. Inkata, Melbourne.

Floyd A. 1990. *Australian Rainforests in NSW.* Volume 2. Surrey Beatty & Sons / NPWS, Chipping Norton.

Forshaw JM & Cooper. 1981. *Australian Parrots.* 2nd Edition. Landsdowne, Melbourne.

Fraser G & Mendel G. 1976. The Bush-hen in NSW. *Australian Birds* **11(2)**: 25-27.

Frith HJ. 1982. *Pigeons and Doves of Australia.* Rigby, Adelaide.

Garnett S. 1992a. *Threatened and Extinct Birds of Australia.* RAOU Report 82. RAOU & ANP&WS, Moonee Ponds.

Garnett S. 1992b. *The Action Plan for Australian Birds.* Australian National Parks & Wildlife Service.

Gilmore AM & Associates. 1995. *Environmental Study of Wetland South of Pottsville NSW - Wildlife Survey.*

Gilmore AM & Parnaby HE. 1994. *Vertebrate Fauna of Conservation Concern in North-east NSW Forests.* North East Forests Biodiversity Study Report No 3E, unpublished. National Parks & Wildlife Service, Hurstville.

Gordon G. 1995. Northern Brown Bandicoot *Isoodon macrourus.* In R Strahan (*ed*). *The Mammals of Australia.* p174-75. Australian Museum/Reed Books, Chatswood.

Griffith S. 1993. *Conservation Status of Coastal Plant Communities in Northern New South Wales.* NSW National Parks & Wildlife Service.

Hager T & Benson J. 1994. *Conservation Status of Forest Communities in North East NSW.* Report to the Australian Heritage Commission. NSW National Parks and Wildlife Service, Hurstville.

Hall LS & Richards GC. 1979. *Bats of Eastern Australia.* Booklet No 12. Queensland Museum, Brisbane.

Hall LS. 1995. Black Flying Fox *Pteropus alecto.* In R Strahan (*ed*). *The Mammals of Australia.* p432-433. Australian Museum/Reed Books, Chatswood.

Harden GJ (*ed*). 1990. *Flora of NSW, Vol 1.* NSW University Press. Kensington
1991. *Flora of NSW, Vol 2.* NSW University Press, Kensington.
1992. *Flora of NSW, Vol 3.* NSW University Press, Kensington.
1993. *Flora of NSW, Vol 4.* NSW University Press, Kensington.

Higgins PJ & Davies SJJF. 1996. *Handbook of Australian, New Zealand & Antarctic Birds, Volume 3 - Snipe to Pigeons.* Oxford University Press, Melbourne.

Hollands D. 1991. *Birds of the Night.* Reed Books, Balgowlah.

Holmes G. *The Biology and Ecology of Coxen's Fig-Parrot.* RAOU Report No 65. Royal Ornithological Union, Victoria.

How RA. 1995. Mountain Brushtail Possum *Trichosurus caninus.* In R Strahan (*ed*). *The Mammals of Australia.* p271-2. Australian Museum/Reed Books, Chatswood

Hoye GA & Richards GC. 1995. Greater Broad-nosed Bat *Scoteanax rueppellii.* In R Strahan (*ed*). *The Mammals of Australia.* p527-528. Australian Museum/Reed Books, Chatswood.

Hunter RJ. 1992. *Assessment of Rainforest Stands in Smoky Valley Area.* NSW National Parks & Wildlife Service.

IBRA. 1995. *An Interim Biogeographic Regionalisation for Australia.* Australian Nature Conservation Agency, Canberra.

Johnston PG. 1995. Long-nosed Potoroo *Potorous tridactylus.* In R Strahan (*ed*). *The Mammals of Australia.* p301-302. Australian Museum/Reed Books, Chatswood.

Jones A, Watson Russell C & Murray A. 1986. Spatial Patterns in the Macrobenthic Communities of the Hawkesbury Estuary, NSW. *Australian Journal of Marine and Freshwater Research* **38**:521-43.

Jones A. 1987. Temporal Patterns in the Macrobenthic Communities of the Hawkesbury Estuary, NSW. *Australian Journal of Marine and Freshwater Research* **38**:607-24.

Kennedy M. 1992. *Australian Marsupial and Monotremes: An Action Plan for their Conservation.* ICUN/SSC Australasian Marsupial and Monotreme Specialist Group.

Kikkawa J. 1993. Conservation of Rainforest Birds in Queensland. *In Birds and their Habitats: Status and Conservation in Queensland.* Queensland Ornithological Society Inc.

Kinhill 1996. *Pacific Highway - Brunswick River to Billinudgel: Route Constraints Study and Preliminary Investigations.* Kinhill Cameron McNamara, Milton.

Landmark Ecological Services. 1994. *State Highway Number 10 Pacific Highway Brunswick Heads Bypass Flora Survey* (Orchid Species and *Acronychia littoralis* Stand).

Lauro B & Nol E. 1995. Patterns of habitat use for Pied and Sooty Oystercatchers nesting at the Furneaux Islands, Australia. *The Condor* **97**: 920-934.

Law BS. 1993. Roosting and Foraging Ecology of the Queensland Blossom Bat (*Syconycteris australis*) in North-eastern NSW: Flexibility in Response to Seasonal Variation. *Wildlife Research* **20**: 419-431.

Law BS & Spencer HJ. 1995. Common Blossom-bat *Syconycteris australis.* In R Strahan (*ed*). *The Mammals of Australia.* p423-425. The Australian Museum/Reed Books, Chatswood.

Lee A & Martin R. 1988. *The Koala: a natural history.* NSW University Press, Kensington.

LES. 1994. *State Highway No.10 Pacific Highway. Brunswick Heads Bypass Flora Survey (Orchid Species and Acronychia littoralis Stand).* Landmark Ecological Services Pty Ltd.

Lindsey TR. 1992. *Encyclopedia of Australian Animals - Birds.* The Australian Museum, Sydney.

Maciejewski S. 1993. *The Foraging Habitat of the Osprey (Pandion haliaetus critatus) in the Lower Richmond Estuary.* The University of New England Northern Rivers.

Mahoney MJ. 1993. The status of frogs in the Watagan Mountains area, the Central Coast of New South Wales. In Lunney D & Ayers D (*eds*). *Herpetology in Australia.* p257-64. *Surrey Beatty & Sons,* Sydney.

Marchant S & Higgins PJ. 1990a. *Handbook of Australian, New Zealand & Antarctic Birds.* Volume 1: Ratites to Ducks, Part A. Oxford University Press, Melbourne.

Marchant S & Higgins PJ. 1990b. *Handbook of Australian, New Zealand & Antarctic Birds.* Volume 1: Ratites to Ducks, Part B. Oxford University Press, Melbourne.

Marchant S & Higgins PJ (*eds*). 1993. *Handbook of Australian, New Zealand and Antarctic Birds.* Volume 2 - Raptors to Lapwings. Oxford University Press, Melbourne.

Martin RW & Handasyde KA. 1995. Koala *Phascolarctos cinereus.* In R Strahan (*ed*). *The Mammals of Australia.* p196-198. Australian Museum/Reed Books, Chatswood.

Maxwell S, Burbidge R & Morris K. 1996. *The 1996 Action Plan for Australian Marsupials & Monotremes.* NP&WS, Canberra.

McKay GM & Ong P. 1995. Common Ringtail Possum *Pseudocheirus peregrinus.* In R Strahan (*ed*). *The Mammals of Australia.* p254-6. Australian Museum/Reed Books, Chatswood.

Menkhorst P, Weavers B & Alexander J. 1988. Distribution, habitat and conservation status of the Squirrel Glider *Petaurus norfolcensis* (Petauridae: Marsupialia) in Victoria. *Australian Wildlife Research* **15(1)**: 59-72.

Merchant JC. 1995. Swamp Wallaby *Wallabia bicolor.* In R Strahan (*ed*). *The Mammals of Australia.* p404-05. Australian Museum/Reed Books, Chatswood.

Milledge DR. 1991. A survey of the terrestrial vertebrates of coastal Byron Shire. *Australian Zoologist* **27**: 66-90.

Milledge D & McKinley A. 1992. *A Flora and Fauna Survey for the Route Selection Study, Proposed Pacific Highway Bypass, Brunswick Heads/Pacific Highway - State Highway No 10 Brunswick Heads Bypass EIS, Volume 2 - Fauna Impact Statement.* Roads & Traffic Authority.

MKES. 1994. *Proposed Motorway Billinudgel to Chinderah: Environmental Impact Statement.* Flora and Fauna Working Paper including Fauna Impact Statements. Mount King Ecological Surveys, Oberon. Mount King Ecological Surveys, Oberon.

Morris AK, McGill AR & Holmes G. 1981. *Handlist of Birds in New South Wales.* NSW Field Ornithologists Club, Sydney.

Morris AK & Burton A 1993. NSW Annual Bird Report 1991. *Aust Birds* **27**: 29-76

Muranyi M. 1994. *The Distribution and Habitat Preference of the Bush-hen, Amaurornis olivacea* in the Northern Rivers Region, NSW. Southern Cross University, Lismore.

Nil Desperandum Ecological Consultants. 1994. *Supplementary Vegetation Report. Environmental Impact Statement. Proposed Motorway Billinudgel to Chinderah.*

NP&WS. 1992. *North East Bio News. Newsletter of the North East NSW Biodivesity Survey.* NSW National Parks & Wildlife Service, Hurstville.

NP&WS. 1993. *The Byron Group of Nature Reserves (Incorporating Brunswick heads, Tyagarah and Broken Head Nature Reserves).* Draft Plan of Management. NSW National Parks & Wildlife Service, Hurstville.

NP&WS. 1994. *Big Scrub Nature Reserves (Incorporating Andrew Johnston Big Scrub, Victoria Park, Davis Scrub, Hayters Hill, Boatharbour and Wilson Nature Reserves*). Draft Plan of Management. NSW National Parks & Wildlife Service, Hurstville.

NP&WS. 1995. *Vegetation survey and mapping of Upper North Eastern NSW.* Report to the Natural Resources Council. NSW National Parks & Wildlife Service, Hurstville.

NP&WS. 1996. *Draft Species Recovery Plan for Elaeocarpus williamsianus.* NSW National Parks & Wildlife Service, Hurstville.

Oehlman RK. 1997. *Road Kill Hotspots.* Unpublished report from Northern River Wildlife Carers.

Pahl L, Whylie FR & Fisher R. 1991. Koala Population Declines Associated with Loss of Habitat and Suggested Remedial Strategies. In D Lunney, CA Urquart & PC Reed (*eds*). *Koala Summit: Managing Koalas in NSW.* p39-47. NSW National Parks and Wildlife Service, Hurstville.

Parker P. 1992. *Brunswick Heads EIS: Aquatic Flora and Fauna.* Peter Parker Environmental Consultants, Broken Head.

Parnaby H. 1995a. Eastern Forest Bat *Vespadelus pumilus.* In R Strahan (*ed*). *The Mammals of Australia.* p541-542. Australian Museum/Reed Books, Chatswood.

Parnaby H. 1995b. Eastern Long-eared Bat *Nyctophilus bifax.* In R Strahan (*ed*). *The Mammals of Australia.* p500-1. Australian Museum/Reed Books, Chatswood.

Phillips B. 1990. *Koalas: The Little Australians we'd all Hate to Lose.* Australian National Parks and Wildlife Service, Canberra.

Poole AF. 1989. *Ospreys: A Natural and Unnatural History.* Cambridge University Press.

QEM. 1994a. *Flora and non-Koala Fauna Review. State Highway No.10 - Pacific Highway. Billinudgel to Chinderah Motorway.* Quality Environmental Management Pty Ltd, Wollongong.

QEM. 1994b. *Koala Review. State Highway No.10 - Pacific Highway. Billinudgel to Chinderah Motorway.* Quality Environmental Management Pty Ltd, Wollongong.

Quinn FC, Williams JB, Gross CL & Bruhl JJ. 1995. *Report on Rare or Threatened Plants of North-eastern New South Wales.*

RACAC. 1996. *Draft Interim Forest Assessment Report.* Resource & Conservation Assessment Council, Sydney.

Recher HF, Date E & Ford H. 1995. *The Biology and Management of Rainforest Pigeons in NSW.* Species Management Report No 16. NSW National Parks & Wildlife Service, Hurstville.

Reed PC & Lunney D. 1990. Habitat loss: the key problem for the long term survival of koalas in NSW. In D Lunney, CA Urguhart, & PC Reed (*eds*). *Koala Summit: Managing the Koala in NSW.* P9-31. NSW National Parks & Widlife Service, Hurstville.

Reed PC, Lunney D & Walker P. 1990. A 1986-87 survey of the koala *Phascolarctos cinereus* Goldfuss in New South Wales and an ecological interpretation of its distribution. In AK Lee, KA Handasyde, & GD Sanson (*eds*). *The Biology of the Koala.* P55-78. Surrey Beatty and Sons, Sydney.

Recher FR, Date EM & Ford HA. 1995. *The Biology and Management of Rainforest Pigeons in NSW.* Species Management Report Number 16, NSW National Parks & Wildlife Service, Hurstville.

Redhead TD. 1995. Fawn-footed Melomys *Melomys cervinipes.* In R Strahan (*ed*). *The Mammals of Australia.* p636-7. Australian Museum/Reed Books, Chatswood.

Richards GC. 1995. Large-footed Myotis *Myotis adversus.* In R Strahan (*ed*). *The Mammals of Australia.* p521-523. Australian Museum/Reed, Chatswood.

RTA. 1993. Pacific Highway - State Highway No 10. Brunswick Heads Bypass. Roads & Traffic Authority of NSW.

Schodde R & Mason I. 1980. *Nocturnal Birds of Australia.* Landsdowne, Melbourne.

Schodde R & Tidemann S. 1986. *Readers Didest Complete Book of Australian Birds.* Second Edition. Readers Digest, Sydney.

Scribner EA & Kathuria A. 1996. NSW Commercial Fisheries Statistics - 1992/93. NSW Fisheries.

Sheringham P & Westaway J. 1995. *Significant Vascular Plants of Upper North East NSW.* A report by the NSW NP&WS for the Natural Resources Audit Council.

Soderquist T. 1995. Brush-tailed Phascogale *Phascogale tapoatafa.* In R Strahan (*ed*). *The Mammals of Australia.* p104-106. Australian Museum/Reed Books, Chatswood.

Stodart E. 1995. Long-nosed Bandicoot *Perameles nasuta.* In R Strahan (*ed*). *The Mammals of Australia.* p184-185. Australian Museum/Reed Books, Chatswood.

Strahan R. 1995. *Encyclopedia of Australian Animals: Mammals.* The Australian Museum, Sydney.

Suckling GC. 1995. Squirrel Glider *Petaurus norfolcensis.* In R Strahan (*ed*). *The Mammals of Australia.* p234-5 Australian Museum/Reed Books, Chatswood.

Tanton MT. 1996. *Environmental Impact Statement: Murwillumbah Management Area.* State Forests of NSW, Pennant Hills.

Tidemann CR. 1995a. Grey-headed Flying-fox *Pteropus poliocephalus.* In R Strahan (*ed*). *The Mammals of Australia.* p439-41. Australian Museum/Reed Books, Chatswood.

Tidemann CR. 1995b. Eastern Broad-nosed Bat *Scotorepens orion.* In R Strahan (*ed*). *The Mammals of Australia.* p531-532. Australian Museum/Reed Books, Chatswood.

Walker J & Hopkins M S. 1990. Vegetation. In RC McDonald, RF Isbell, JG Speight, J Walker and JS Hopkins (*eds*). *Australian Soil and Land Survey.* Inkata Press, Melbourne.

WBM Oceanics. 1996. *Murwillumbah Management Area EIS Supporting Document No 1: Flora Report.* Murwillumbah Management Area, Northern Region, State Forests of NSW.

West RJ & Gordon GNG. 1994. Commercial and recreational harvest of fish from two Australian coastal rivers. *Water Research* 45, 1259-1279.

White AW. 1997. Green and Golden Bell Frog. In Ehmann H (*ed*). *Threatened Frogs of New South Wales: Habitat, Status and Conservation.* p49-56. Frog and Tadpole Study Group of NSW Inc, Sydney South.

Williams JB & Harden GJ. 1984. *The Vegetation and Flora of Brunswick Heads, NSW.* Department of Botany, University of New England.

Williams JB, Harden GJ & McDonald WJF. 1984. *Trees and Shrubs in Rainforests of New South Wales and Southern Queensland.* University of New England Printery, Armidale.

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 1

Detailed Flora Survey Methods

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APPENDIX 1 Details of flora surveys conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

1 OBJECTIVES

- To classify and map the distribution of plant communities at a scale and level of detail appropriate for impact assessment and for the evaluation of regional and local conservation significance.
- To conduct a thorough botanical survey resulting in a comprehensive inventory of the flora present, with particular attention to rare and threatened plant species.
- To determine the relationships between habitats, plant communities, rare and threatened plant species and the physical environment.

2 SURVEY DESIGN

The survey design was based on consideration of:

- aerial photograph interpretation;
- stratification of survey sites;
- plot location;
- replication; and
- data analysis.

Flora surveys were designed to obtain adequate sampling of the full range of environmental variations, as determined from topographic and geological maps and preliminary air photo interpretation of vegetation patterns. Standardised vegetation survey and mapping techniques were employed, following methods described in NP&WS (1995) and the 'random meander technique'.

2.1 Aerial Photograph Interpretation (API)

Aerial photograph interpretation was conducted using large scale colour photographs (Brunswick to Yelgun 1:5435 and Brunswick Bypass Duplication 1:8000). In addition, 1:25000 colour air photographs were used in the Brunswick River to Yelgun study for areas more than 0.5km (approximately) from the existing highway.

Preliminary vegetation type boundaries were traced on to transparent photo overlays. Where stereo-pairs were available, photos were marked up with the effective area (*ie* central part of photograph with minimal distortion) and examined using a stereoscope. Following standard API techniques (NP&WS 1995), polygons were drawn onto overlays to enclose areas more or less uniform in terms of combinations of land cover, texture, forest crown size and land unit characteristics (*eg* slope, aspect and topographic position).

Following preliminary API, ground-truthing was conducted to identify and describe vegetation types corresponding to the mapped polygons, some of which were further divided, modified or amalgamated as a consequence of observations made during fieldwork. Field identification of photo-patterns is essential in mapping from API, and the greater the amount of ground-truthing, the more accurate the final map. The polygons resulting from this process represent multivariate entities derived by air photo interpretation and ground-truthing, which is integrated with and constrained by a framework of established ecological principles and relationships (vegetation communities and associations).

2.2 Stratification

Field traverses and survey sites were stratified to ensure sampling of the full range of environmental variation in the study area. A combination of classes of topography, geology and broad API vegetation types were used to stratify the sampling sites (Table 1).

Three topographic classes, equivalent to landform units (McDonald *et al* 1990), were used in the stratification:

(i) footslopes and flats;
(ii) exposed slopes and ridges; and
(iii) protected slopes and gullies.

2.2 **Stratification** contd

Three geological classes were used in the stratification process:

(i) metasediment;
(ii) basalt; and
(iii) recent alluvium or sand.

The spatial extent of topographic and geological strata was assessed from the Brunswick Heads 1:25000 topographic map and the Lismore 1:250000 geological map, respectively.

The initial stratification provided an appropriate starting point for sampling the study area. However, the high intensity of survey effort permitted repeated examination of equivalent strata combinations in different areas, resulting in a much more detailed than usual examination of the range of environmental variation.

Table 1 Stratification table showing combinations of environmental variables considered in stratifying survey sites and traverses.

Broad Vegetation Type	Geology	Topography	Number of Strata
Moist Forest (*eg* Brush Box, moist Blackbutt)	metasediment	protected slopes	1
Dry Forest	sand	flats	1
Rainforest (mature and advanced regrowth)	metasediment, basalt, alluvium	protected slopes and gullies	3
Disturbed Regrowth	metasediment, alluvium	protected, exposed	4
Swamp Sclerophyll	alluvium	swampy flats	1

2.3 Field Survey

Intensive field surveys were conducted to generate an inventory of flora species, to ground-truth the API vegetation boundaries and to describe the vegetation communities present. The study area was inventoried by ground traverses which were located by a random stratified method, so as to intersect the full range of combinations of broad vegetation type, topography and geology. Initially it was efficient to collect data for all three purposes simultaneously, but as the vegetation map was refined, surveys focussed primarily on flora inventory and targeted searches for rare and threatened plant species.

Nearly all vegetation polygons identified during API were inspected on the ground, involving a high survey intensity for flora inventories. The preferred route (Route A2) was searched by repeated traverses, no more then 20 metres apart. Survey intensity in other areas varied according to the likelihood of habitats supporting rare and threatened plant species.

2.3.1 Site Vegetation Description

Detailed vegetation and environmental attributes were recorded within representative vegetation associations, the latter having been identified on the ground in conjunction with API. These representative sampling sites were not confined to a fixed area, but were generally located within a radius of approximately 25m (NP&WS 1995). Sites were located to avoid sampling apparent boundaries between vegetation types.

2.3.1 Site Vegetation Description contd

Sites were geo-referenced and replicated for more extensive associations. The following data were recorded at sites, following methods set out in NP&WS (1995):

Vegetation Structure
- upper stratum height
- % crown cover

Floristics
- dominant and common upper stratum species
- common mid-stratum species
- common lower stratum species

Environmental Attributes
- topographic position
- slope
- aspect
- geology

Disturbance History
- evidence of fire, logging, clearing
- time since last major disturbance event

Vegetation Condition
- The condition or intactness of plant communities was assessed as poor, fair or good. The three categories of condition represent a relative, qualitative scale based on the following criteria for each association - area, structural maturity, species diversity, weed infestation and the impact of disturbance.

3 DATES of SURVEYS

Route Selection Study

Dr S Clark	17-19 Dec 1996
Mr A Benwell	21 Jan 1997; 4-5 April 1997; 12-13 April 1997.

Final Study

Mr A Benwell	14, 16, 31 July 1997; 17-18 Nov 1997; 1-2, 8, 15, 26-27 Dec 1997.

4 REFERENCES

McDonald R, Isbell R, Speight J, Walker J & Hopkins M. 1990. *Australian Soil and Land Survey Field Handbook*. Inkata, Melbourne.

NP&WS. 1995. *Vegetation survey and mapping of Upper North Eastern NSW*. A report prepared by the NP&WS for the Natural Resources Audit Council, NSW.

PROPOSED DUPLICATION
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APPENDIX 2
Detailed Fauna Survey Methods

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APPENDIX 2 Details of fauna investigations conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

Specific fauna survey methods and survey effort are detailed below, with survey locations indicated on Figure 6. Results of the fauna surveys are provided in Appendix 5, and details of weather conditions during the fauna surveys are provided below.

1 TRAPPING TRANSECTS

Trapping surveys for small and medium-sized mammals were conducted in areas of suitable habitat within the study area for the proposed duplication of the Brunswick Heads Bypass from the 18th to the 22nd November 1997, and in the study area for the upgrade of the Pacific Highway, Brunswick to Yelgun from the 18th to 23rd of November, and from the 27th of November to the 3rd of December 1997. Hairtubes deployed during the latter survey period were collected on the 8th of January 1998.

A combination of standard fauna trapping techniques were utilised along 10 trapline transects at selected representative survey locations (Figure 6). Trapping survey effort is outlined in Table 1.1. Pitfall traps were utilised at only one trapping transect, in particular to target the Common Planigale (see Section 6).

Table 1.1 Location and habitat details of the trapping transects for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun. AMG locations are approximate.

Trapline No.	Location	AMG	Vegetation Type
1	Western side of the existing Bypass	6841600 552500	wet sclerophyll forest with moderate disturbance
2	East of the existing Highway, south of the Brunswick River	6843500 552500	dry sclerophyll forest with moderate disturbance
3	Brunswick Nature Reserve, east of the existing Highway	6843800 552500	subtropical rainforest & wet sclerophyll forest
4	Brunswick Nature Reserve, west of the existing Highway	6843900 552400	subtropical rainforest between wet sclerophyll forest and mangrove communities
5	west of the existing Highway, south of road to sewage treatment plant	6844400 552000	regrowth subtropical rainforest on metasediment
6	west of the existing Highway, north of road to sewage treatment plant	6844500 551900	regrowth subtropical rainforest on metasediment
7	west of the existing Highway, south of Banana Road	6844700 551600	wet sclerophyll forest
8	west of the existing Highway, north of Coolamon Scenic Drive	6845800 551900	mixed pine and eucalypt plantation
9	Billinudgel Nature Reserve, south of the New Brighton Road	6847500 551500	wet sclerophyll forest
10	Billinudgel Nature Reserve, north of the New Brighton Road	6847600 551400	swamp sclerophyll and pioneer forest regrowth

Table 1.2 Trap types and bait used for the proposed duplication of the Brunswick Heads Bypass and the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Method	Bait
Ground-based Elliott traps	peanut butter/honey/rolled oats
Tree-mounted Elliott traps	peanut butter/honey/rolled oats
Cage traps	peanut butter/honey/rolled oats and chicken
hair tubes*	peanut butter/honey/rolled oats and chicken

* hair samples sent to Ms Michiala Bowen for analysis.

Table 1.3 Details of mammal trapping survey effort for the proposed duplication of the Brunswick Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun. The numbers in parentheses indicate the number of nights the traps were set.

Trapline	Ground-based Elliott Traps	Tree-Mounted Elliott Tarps	Cage Traps	Hair Tubes	Pit-fall Traps**
1	18 (4 nights)	7 (4 nights)	3 (4 nights)	14 (14 nights)	-
2	14 (4 nights)	4 (4 nights)	2 (4 nights)	14 (13 nights)	5 (10 nights)
3	17 (4 nights)	Nil*	2 (4 nights)	11 (14 nights)	*
4	22 (4 nights)	Nil*	3 (4 nights)	14 (12 nights)	*
5	18 (4 nights)	7 (4 nights)	3 (4 nights)	14 (13 nights)	-
6	18 (4 nights)	7 (4 nights)	3 (4 nights)	11 (14 nights)	-
7	20 (4 nights)	5 (4 nights)	3 (4 nights)	16 (41 nights)	-
8	25 (4 nights)	-	3 (4 nights)	16 (41 nights)	-
9	25 (4 nights)	Nil*	3 (4 nights)	16 (41 nights)	*
10	25 (4 nights)	Nil*	3 (4 nights)	16 (41 nights)	*
Bypass	72	28	12	196	-
Upgrade	736	92	100	3464	50
Total Trap-Nights	**808**	**120**	**112**	**3660**	**50**

* Tree-mounted Elliott traps and pit-fall traps were not permitted within Brunswick Heads and Billinudgel NRs as requested by the NP&WS (L Tarvey *pers comm*).

** Dry pitfall trapping targeting the Common Planigale (see Section 6 below).

Trapline 1 study area for the proposed duplication of the Brunswick Heads Bypass.

Traplines 2-10 study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun

2 BAT SURVEYS

Microchiropteran and megachiropteran bat surveys were conducted using one direct method (harp trapping) and one indirect method (Anabat II ultrasonic call recording), in suitable habitat within the study areas for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

2.1 Anabat II Call Detectors

- 11 survey sites were located in different and representative habitat types to maximise the opportunity of detecting different species (Table 2.1; Figure 6);
- Anabat II detectors were set on sound-activation mode, for approximately 2 hours at 3 separate locations on the 19th of November 1997 along the proposed Brunswick Heads Bypass;
- detectors were set on sound-activation mode at 8 different locations along the proposed Brunswick to Yelgun upgrade alignment (Figure 6). The detectors were set for one night at each location over a three night survey period (20th and 27th of November and the 1st of December). The detectors were set for between 2 hours and all night;
- tapes were sent to Mr Glenn Hoye for analysis.

2.2 Harp Traps

2.2.1 Proposed duplication of the Brunswick Heads Bypass study area

- One trap location (Table 2.2);
- conducted over 5 nights (19th-23th January);
- traps placed in likely fly-ways or gullies (where appropriate).

2.2.2 Proposed upgrade of the Pacific Highway, Brunswick River to Yelgun study area

- Three trap locations (Table 2.2);
- conducted over 5-6 nights each (20th to 24th of November and the 29th of November to the 3rd of December 1997);
- traps placed in fly-ways or gullies (where appropriate).

Table 2.1 Anabat II detector locations within the study areas for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun (Figure 6).

Date	Anabat Locations	AMGs	Vegetation Type
19/11/97	Northern end of trapline No 1 (B)	6842500 552450	Melaleuca forest
	Southern end of trapline No 1 (B)	6841800 552500	Melaleuca forest
	eastern side of of southern end of Bypass (B)	6841400 552500	Melaleuca forest
20/11/97	Brunswick Heads NR (U)	6843800 552550	Rainforest
	east of Highway just north of Brunswick Heads NR (U)	6844600 552150	Rainforest
27/11/97	Banana Rd (U)	6844600 551600	Dry sclerophyll open forest
	Banana Rd, near turnoff to quarry (U)	6844800 551550	Dry sclerophyll open forest
1/12/97	Billinudgel NR, off New Brighton Rd (U)	6847400 551800	Open forest
	north of Salad Bowl Caravan Park(U)	6845800 551800	Pine/eucalypt plantation
	Billinudgel NR, north of New Brighton Rd (U)	6847400 551800	Open forest
	Billinudgel NR, south of New Brighton Rd (U)	6846900 551900	Melaleuca/Rainforest

B study area for the proposed duplication of the Brunswick Bypass

U study area for the proposed Pacific Highway Upgrade, from the Brunswick to Yelgun

Table 2.2 Location of harp traps within the proposed Brunswick Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun study areas.

Trap No.	Locations of Harp Trap	AMGs	Vegetation Type
1 (B)	western side of existing Bypass alignment	6841800 552300	Melaleuca forest
2 (U)	west of existing Highway, north of River	6844100 552200	Swamp oak/wet sclerophyll forest
3 (U)	Billinudgel NR, south of New Brighton Road	6846900 551900	Wet sclerophyll forest
4 (U)	Billinudgel NR, north of New Brighton Road	6847400 551800	Swamp sclerophyll forest

B study area for the proposed duplication of the Brunswick Bypass

U study area for the proposed Pacific Highway Upgrade, from the Brunswick to Yelgun

3 SPOTLIGHTING

Extensive spotlighting surveys, including both walked and driven surveys, were conducted throughout the study areas and in the immediate vicinity.

3.1 Proposed duplication of the Brunswick Bypass study area

- conducted on the 19th and 21st of November 1997;

- total of approximately six and a quarter person-hours, including 3 person-hours walked survey of the proposed Bypass duplication alignment; and
- records maintained of all species observed or identified by calls.

3.2 Proposed upgrade of the Pacific Highway, Brunswick River to Yelgun study area

- Conducted in two stages, from the 18th to the 23rd of November 1997, and from the 27th of November to the 3rd of December 1997;
- a total of approximately 31 person-hours.

4 HERPETOLOGICAL SURVEYS

4.1 General

Surveys for reptiles and amphibians were conducted throughout habitats within the study areas for the proposed Bypass duplication and Pacific Highway upgrade and in the immediate vicinity. Surveys involved:

- active diurnal habitat searches, including turning logs, rocks and debris (such as building materials, tyres, rubble stock piles *etc*), searching decorticating and fallen bark, rock outcrops, leaf-litter and other suitable substrates;
- nocturnal surveys for amphibians, involving call identification and direct observation, were conducted during spotlighting surveys and were concentrated in and along creeklines and wetlands, temporary puddles and wet soaks along roads and in stands of vegetation and pasture following rain, and under vegetative debris (such as fallen logs) and refuse (*eg* plastic);
- call playback was not used for amphibian species during the initial fauna investigations, because of the ideal conditions for amphibian surveys (warm to hot temperatures with several rain periods, following recent heavy rains). Many species were active and calling, and it is considered that any threatened species (in particular *Litoria aurea*, *Crinia tinnula* and *Litoria olongburensis*) would also have been calling, if present in the vicinity;
- nocturnal searches were also conducted for reptiles during the spotlighting surveys. Particular emphasis was placed on searching for the White-crowned Snake, Pale-headed Snake and Stephen's Banded Snake, in areas of potential habitat, although these species have not been recorded in the general vicinity during recent investigations (Appendix 4);
- records were maintained of all species observed or identified by call.

4.1 Targeted Amphibian Surveys

Targeted surveys for threatened amphibian species were conducted during the supplementary surveys in April 1998, involving:

- active diurnal searches in areas of suitable habitat throughout both study areas during wet conditions;
- five person-hours spotlighting over two nights (1st and 2nd of April 1998) within the proposed Brunswick bypass duplication study area, with specific emphasis on the detection of threatened amphibians recorded previously in the wider area (Appendix 4); and
- call playback for the Green & Golden Bell Frog *Litoria aurea* at an artificial wetland (552546 6841392) in the proposed Brunswick Heads Bypass duplication study area on the 1st of April 1998.

5 AVIFAUNA SURVEYS

5.1 General Surveys

Avifauna surveys were conducted throughout the study areas for the proposed duplication of Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun. Survey activities included:

- general diurnal bird surveys in all habitats, including rainforest, woodland/open forest, riparian woodland, estuarine wetlands, including saltmarsh and mangroves, freshwater wetlands and agricultural and other disturbed areas;
- spotlighting surveys for nocturnal species (as for spotlighting details above); and
- records maintained of all species observed or identified by call.

5.2 Targeted Surveys

Specific searches were carried out for the following bird species in suitable habitat:

- **Black-necked Stork** - the only suitable habitat for this species is within the proposed Brunswick to Yelgun upgrade study area, including the Brunswick River estuary and associated saltmarsh communities, both of which were searched extensively, as well as opportunistically. Targeted searches were also conducted during the supplementary surveys along Marshalls Creek (in the Brunswick to Yelgun Upgrade study area), but no suitable habitat was located;
- **Black and Australasian Bitterns** - targeted searches for these species were conducted along Marshalls Creek (between 500m and 750m) on either site of the existing Highway, in the Brunswick to Yelgun upgrade study area. Targeted surveys comprised 6 person-hours over two days (1st and 2nd of April 1998);
- **Bush Hen** - Targeted searches for this species were conducted along Marshalls Creek, between 500m and 750m on either site of the existing Highway and along several other creeks north of Ocean Shores, in the Brunswick to Yelgun upgrade study area. Searches comprised 6 person-hours over two days (1st and 2nd of April 1998).
- **Mangrove Honeyeater & Collared Kingfisher** - repeated dedicated searches in mangrove communities along the Bruswick River in the vicinity of the proposed upgrade alignment throughout the duration of the field survey;
- **Superb, Wompoo and Rose Crowned Fruit-Doves, Barred Cuckoo Shrike & White-eared Monarch** - dedicated searches in rainforest communities, in particular in the Brunswick and Billinudgel NRs, along the proposed Brunswick to Yelgun upgrade alignment. Rainforest communities along the proposed alignment were surveyed repeatedly throughout the field investigations;
- **Osprey** - searches for large raptor nests and observation of nests recorded during the survey and known Osprey nests recorded during previous fauna investigations in the general vicinity;
- **Red Goshawk & Square-tailed Kite** - searches for large raptor nests and observation of nests recorded during the survey. Specific searches below raptor nests for pellets;

- **Glossy Black Cockatoo** - limited suitable habitat is present in the study areas investigated. Specific searches were conducted for crushed cones under any She-oaks located;
- **Bush Thick Knee** - spotlighting surveys throughout the study areas in areas of potentially suitable habitat;
- **Marbled Frogmouth** - spotlighting surveys in rainforest communities along the proposed Bypass and upgrade alignments;
- **Powerful, Masked and Sooty Owls** - specific surveys in suitable habitat using owl call broadcasting to elicit response calls (see details below);
- **Eastern Grass Owl** - specific surveys in suitable habitat using call broadcasting to elicit response calls (see details below);
- **Swift Parrot** - general avifauna surveys in suitable habitat.

Owl Call Playback

Owl call playback, targeting the Masked, Powerful and Sooty Owls, was conducted for approximately 1 person - hour at 3 sites in suitable habitat along the proposed Bypass duplication and upgrade alignments (Table 5.1). Call playback at each site comprised an initial listening period of 10 minutes, followed by call broadcasting for 5 minutes, and then a further listening period of 10 minutes. After the final call broadcast, 10 minutes were spent listening for response calls.

Owl call playback, targeting the Eastern Grass Owl, was conducted at two sites along the proposed Bypass and the upgrade alignments (Table 5.1). Call playback at each site comprised an initial listening period of 10 minutes, followed by call broadcasting for 5 minutes, and then a further listening period of 5 minutes.

Table 5.1 Details of owl call playback surveys conducted for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun (Figure 6).

Species	Date	Location	AMG location
Masked, Sooty & Powerful Owls	18/11/97	proposed Bypass (B)	6841800 552450
	18/11/97	Billinudgel NR (U)	6847430 551586
	18/11/97	Banana Road (U)	6844800 551550
Eastern Grass Owl	01/04/98	proposed Bypass (B)	6842800 552426
		Billinudgel NR (U)	6847430 551586
	02/04/98	proposed Bypass (B)	6842800 552426
		Billinudgel NR (U)	6847430 551586

B study area for the proposed duplication of the Brunswick Bypass.

U study area for the proposed Pacific Highway Upgrade, from the Brunswick to Yelgun.

6 MAMMAL SURVEYS

In addition to the extensive trapping investigations detailed in Section 1 of this Appendix, targeted surveys were conducted for the Koala and Common Planigale.

Koala

- Koala scat surveys were undertaken in representative areas of potential habitat (vegetation communities which supported potential feed trees) within the proposed Brunswick to Yelgun upgrade study area (Figure 6);
- dedicated scat searches were not conducted in the proposed Brunswick Heads Bypass duplication study area, given that this area was inundated with water at the time of the survey, although opportunistic searches were undertaken on several occassions;
- a total of 121 trees were examined in the proposed Brunswick to Yelgun upgrade study area for Koala scratches and for the presence of Koala scats around their bases;
- trees with a DBH of >20cm were selected where available and preferred Koala food trees were targeted, including Forest Red Gum *Eucalyptus tereticornis*, Tallow-wood *microcorys*, Spotted Gum *Corymbia maculata* and stringybark and ironbark species. Where preferred food trees were not present, other healthy mature trees were selected for survey, including Brush Box *Lophostemon confertus*;
- opportunistic searches for Koala scats were conducted throughout the study areas.

Table 6.1 Locations of Koala scat searches conducted for the proposed upgrade of the Pacific Highway, Brunswick River to Yelgun (Figure 6). AMGs are approximate.

Location	Grid Reference	Trees Searched	Species Name	No Searched
Brunswick NR (eastern side)	6843850 552600	Pink Bloodwood	*Eucalyptus intermedia*	19
		Tallow-wood	*Eucalyptus microcorys*	20
		Forest Red Gum	*Eucalyptus tereticornis*	4
		Brush Box	*Lophostemon confertus*	7
Banana Rd area	6845200 551500	Flooded Gum	*Eucalyptus grandis*	20
Billinudgel NR	6847150 552100	Tallow-wood	*Eucalyptus microcorys*	20
		Brush Box	*Lophostemon confertus*	6
		Pink Bloodwood	*Eucalyptus intermedia*	25

Common Planigale

Dry pitfall trapping targeting the Common Planigale was only carried along trapline 2, located on the southern side of the Brunswick River (in the proposed Brunswick to Yelgun upgrade study area). Pitfall traps were not used at the other trapping survey locations for the following reasons:

Trapline 1 the installation of dry pitfall traps was prevented by recent heavy rainfall and the inundation of this survey site and the surrounding area.

Trapline 3 located within Brunswick Nature Reserve. The NP&WS does not permit the installation of pitfall traps in Nature Reserves.

Trapline 4	located within Brunswick Nature Reserve. The NP&WS does not permit the installation of pitfall traps in Nature Reserves.
Trapline 5	the local terrain was too steep and rocky for the installation of pitfall traps.
Trapline 6	the local terrain was too steep and rocky for the installation of pitfall traps.
Trapline 7	the local terrain was too steep for the installation of pitfall traps.
Trapline 8	mixed pine and eucalypt plantation. Not considered suitable habitat for the Common Planigale.
Trapline 9	located within Billinudgel Nature Reserve. The NP&WS does not permit the installation of pitfall traps in Nature Reserves.
Trapline 10	located within Billinudgel Nature Reserve. The NP&WS does not permit the installation of pitfall traps in Nature Reserves.

7 GENERAL HABITAT SEARCHES

- Habitat searches to detect the presence or absence of tree-hollows and tree-hollow sizes and other features of relevance for native fauna throughout the study areas, such as specific fauna food trees (*eg* Tallow-wood for Koalas and She-oaks for Glossy Black Cockatoos), rock out-crops, wetlands, watercourses *etc*;
- general habitat searches for indirect evidence of fauna, including diggings, scratchings, feeding scars on trees, remains (bones, fur, feathers), owl white-wash, scats, prints, nests *etc*; and
- scats, bones or hair collected were sent to Ms Michiala Bowen for analysis.

8 OPPORTUNISTIC OBSERVATIONS

Records were maintained of all species observed or identified from calls while conducting all survey work and travelling between survey sites.

9 WEATHER CONDITIONS

Date	Time	Temp °C	Cloud	Rain	Wind
13/11/97	Morning	23-28	0	none	calm
	Afternoon	26-31	0	none	calm
18/11/97	Afternoon	22-27	8/8	intermittent	calm
	Evening	20-25	8/8	intermittent	light
19/11/97	Morning	15-20	8/8	none	calm
	Afternoon	20-25	8/8	none	calm
	Evening	18-23	4/8	none	clam
20/11/97	Morning	21-26	8/8	none	light
	Afternoon	24-29	8/8	none	light
	Evening	20-25	6/8	none	calm
21/11/97	Morning	22-27	4/8	none	light
	Afternoon	24-29	0	none	light
	Evening	19-24	0	none	calm
22/11/97	Morning	23-28	0	none	calm
	Afternoon	25-30	0	none	calm
	Evening	22-27	0	none	light
27/11/92	Morning	26-30	0	none	calm
	Afternoon	30-35	0	none	light
	Evening	28-32	0	none	moderate
28/11/97	Morning	24-29	0	none	light
	Afternoon	28-33	0	none	light
	Evening	26-31	0	none	light

9 contd WEATHER CONDITIONS

Date	Time	Temp °C	Cloud	Rain	Wind
29/11/97	Morning	28-33	0	none	calm
	Afternoon	30-35	0	none	calm
	Evening	26-31	0	none	moderate
30/11/97	Morning	26-31	0	none	calm
	Afternoon	29-34	4/8	none	calm
	Evening	27-32	8/8	steady rain	moderate
1/12/97	Morning	27-32	8/8	none	calm
	Afternoon	30-35	0	none	light
	Evening	26-31	0	none	light
2/12/97	Morning	28-32	0	none	light
	Afternoon	30-35	0	none	calm
	Evening	25-30	0	none	light
3/12/97	Morning	28-33	0	none	light
Supplementary Surveys					
1/4/98	Morning	17-19	8/8	steady rain	calm
	Afternoon	19-21	8/8	intermittent showers	calm
	Evening	17-19	8/8	intermittent showers	calm
2/4/98	Morning	18-20	8/8	heavy rain	calm
	Afternoon	20-22	8/8	heavy rain	calm
	Evening	17-19	4/8	scattered showers	light

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 3a

Flora Species Recorded
Proposed Duplication of the Brunswick Heads Bypass Study Area

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APPENDIX 3a Flora species recorded in the study area for the proposed duplication of the Brunswick Heads Bypass.

Key

Broad Vegetation Types:

1 Swamp sclerophyll forest and woodland
2 Dry sclerophyll forest and woodland
3 Subtropical rainforest remnants - secondary regrowth
4 Cleared Pasture

* Introduced species

BOTANICAL NAME	COMMON NAME	BROAD VEGETATION TYPES			
		1	2	3	4
FILICOPSIDA					
Aspleniaceae					
Asplenium australasicum	Bird's Nest Fern			×	
Blechnaceae					
Blechnum indicum	Bungwal Fern	×			
Cyatheaceae					
Cyathea cooperi	Straw Treefern	×			
Dennstaedtiaceae					
Calochlaena dubia	Common Ground Fern	×	×	×	
Histiopteris incisa	Batis Wing Fern	×			
Hypolepis muelleri	Harsh Ground Fern	×			×
Pteridium esculenteum	Bracken Fern	×	×	×	×
Gleicheniaceae					
Gleichenia dicarpa	Pouched Coral Fern	×			
Osmundaceae					
Todea barbara	King Fern	×			
Polypodiaceae					
Dictymia brownii				×	
Pteridaceae					
Acrostichum speciosum	Mangrove Fern	×			
Schizaeaceae					
Lygodium microphyllum	Climbing Fern	×			
CONIFEROPSIDA					
Araucariaceae					
Araucaria cunninghamii	Hoop Pine				×
Cupressaceae					
Callitris columellaris	Coastal Cypress Pine		×		
MAGNOLIOPSIDA - MONOCOTYLEDONS					
Araceae					
Alocasia brisbanensis	Elephants Ears	×			
Asteliaceae					
Cordyline rubra	Small-leaved Cordyline	×			
Amaryillidaceae					
Crinum pedunculatum	Swamp Lily	×			
Arecaceae					
Archontophoenix cunninghamiana	Bangalow Palm	×			
Calamus muelleri	Southern Lawyer Vine			×	
Livistona australis	Cabbage Tree Palm	×			
Cyperaceae					
Baumea rubiginosa		×			
Baumea teretifolia		×			
Cyperus exaltatus		×			
Cyperus lucidus		×			
Cyprus haspan ssp *juncoides*		×			
Cyprus polystachyos		×			
Fimbrystylis dichotoma		×			×
Fimbrystylis nutans		×			×
Gahnia clarkei		×			×
Gahnia sieberana		×			
Isolepis inundata		×			
Schoenus brevifolius		×			×

APPENDIX 3a contd Flora species recorded in the study area for the proposed duplication of the Brunswick Heads Bypass.

BOTANICAL NAME	COMMON NAME	BROAD VEGETATION TYPES			
		1	2	3	4
Junceae					
Juncus kraussii subsp *australiensis*		×			×
Juncus usitatus					×
Juncaginaceae					
Triglochin striatum		×			
Lomandraceae					
Lomandra longifolia	Flat-leaved Mat Rush	×	×	×	×
Luzuriagaceae					
Geitonoplesium cymosum	Scrambling Lily		×	×	
Orchidaceae					
Arthrochilus prolixus	Hammer Orchid	×			
Phormiaceae					
Dianella caerulea	Blue Flax Lily		×		
Poaceae					
**Axonopus affinis*	Carpet Grass			×	×
Cynodon dactylon	Couch Grass		×		×
**Diplachne uninervia*		×			
Echinochloa telmatophila	Marsh Barnyard Grass	×			
Entolasia stricta			×		
Eragrostis parviflora	Weeping Love Grass	×			
Imperata cylindrica var *major*	Blady Grass	×	×		×
Ischaemum australe		×			×
Oplismenus imbecillis				×	
Paspalum orbiculare	Ditch Millet				×
**Paspalum urvillei*	Vasey Grass		×		×
Sacciolepis indica	Indian Cup Grass	×			×
**Setaria sphacelata*	South African Pigeon Grass				×
Restionaceae					
Restio tetraphyllus	Feather Plant	×	×		
Smilacaeae					
Ripogonum elseyanum	Hairy Supplejack	×			
Smilax australis	Barb-wire Vine	×	×	×	
Xanthorrhoeaceae					
Xanthorrhoea johnsoni	Grass Tree		×		
Xyridaceae					
Xyris operculata		×			
Zingiberaceae					
Alpinia caerulea				×	
MAGNOLIOPSIDA-DICOTYLEDONS					
Apiaceae					
Platysace lanceolata			×		
Apocynaceae					
Parsonsia straminea	Common Silk Pod Vine	×	×	×	
Araliaceae					
Polyscias elegans	Celerywood			×	
**Schefflera actinophylla*	Umbrella Tree	×		×	
Asteraceae					
**Ageratina adenophora*	Crofton Weed			×	×
**Ageratina riparia*	Mist Flower			×	×
**Ambrosia artemisifolia*	Rag Weed				
**Aster subulatus*	Wild Aster				×
**Baccharis halimifolia*	Groundsel Bush	×		×	×
**Cirsium vulgare*	Spear Thistle	×			×
**Conyza bonariensis*	Fleabane		×		×
**Crassocephalum crepidIoides*	Thickheads	×			×
**Hypochaeris radicata*	Cat's Ear				×
**Senecio madagascariensis*	Fireweed				×
Avicenniaceae					
Avicennia marina var *australasica*			×		
Celastraceae					
Siphonodon australis	Ivorywood			×	
Cunoniaceae					
Callicoma serratifolia	Callicoma	×			
Dilleniaceae					
Hibbertia scandens	Guinea Flower	×	×		

APPENDIX 3a contd Flora species recorded in the study area for the proposed duplication of the Brunswick Heads Bypass.

BOTANICAL NAME	COMMON NAME	BROAD VEGETATION TYPES			
		1	2	3	4
Elaeocarpaceae					
Elaeocarpus obovatus	Hard Quandong			×	
Epacridaceae					
Leucopogon leptospermoides	Teatree Beard Heath		×		
Leucopogon margarodes	Pearl Beard Heath		×		
Euphorbiaceae					
Actephila lindleyi	Actephila			×	
Croton verreauxii	Native Cascarilla			×	
Drypetes australasica	Yellow Tulip			×	
Glochidion ferdinandi var *ferdinandi*	Cheese Tree	×		×	
Glochidion sumatranum	Umbrella Cheese Tree	×		×	
Macaranga tanarius	Macaranga			×	
Mallotus discolor	White Kamala			×	
Mallotus philippensis	Red Kamala			×	
Fabaceae: Faboideae					
Chorizema parviflora	Chorizema	×	×		
Desmodium nemorosum		×			
Kennedia rubicunda	Running Postman		×	×	×
Milletia australis	Native Wisteria	×		×	
Mucuna gigantea	Burny Bean	×		×	
Oxylobium robustum	Golden Shaggy Pea		×		
Pultenaea villosa	Hairy Bush Pea		×	×	
Fabaceae: Mimosoideae					
Acacia aulacocarpa	Coastal Hickory Wattle		×	×	
Acacia melanoxylon	Sally Wattle	×	×	×	×
Acacia ulicifolia	Prickly Moses		×		
Flacourtiaceae					
**Flacourtia jangomans*	Jangoman's Plum		×		
Goodeniaceae					
Goodenia paniculata		×			×
Haloragaceae					
Gonocarpus tetragynus			×	×	×
Lauraceae					
Endiandra discolor	Domatia Tree	×			
Endiandra sieberi	Hard Corkwood		×		
Litsea australis	Brown Bolly Gum			×	
Lobeliaceae					
Pratia purpurascens	Poison Pratia				×
Oleaceae					
Notelaea longifolia	Mock Olive			×	
Melastomataceae					
Melastoma affine	Native Lasiandra	×			
Malvaceae					
**Sida rhombifolia*	Paddy's Lucerne			×	×
Monimiaceae					
Wilkiea huegeliana	Veiny Wilkea			×	
Moraceae					
Ficus coronata	Creek Sandpaper Fig	×		×	
Ficus fraseri	Sandpaper Fig			×	
Ficus macrophylla subsp *macrophylla*	Morton Bay Fig			×	
Ficus virens var *sublanceolata*	White Fig			×	
Maclura cochinchinensis	Orange Thorn			×	
Streblus brunonianus	Whalebone Tree			×	
Myoporaceae					
Myoporum acuminatum		×			
Myrsinaceae					
Aegiceras corniculatum	River Mangrove	×			
Rapanea howittiana	Brush Muttonwood	×			
Myrtaceae					
Acmena smithii	Lilly Pilly	×	×	×	
Austromyrtus dulcis	Midgenberry		×		
Baekea stenophylla	Weeping Baekea	×			
Callistemon salignus	Willow Bottlebrush	×		×	
Eucalyptus grandis	Flooded Gum			×	
Eucalyptus pilularis	Blackbutt		×		
Eucalyptus robusta	Swamp Mahogany	×	×		
Eucalyptus tereticornis	Forest Red Gum	×			
Leptospermum whitei	Whites Tea-tree		×		
Leptospermum polygalifolium	Common Tea-tea	×	×	×	

APPENDIX 3a contd Flora species recorded in the study area for the proposed duplication of the Brunswick Heads Bypass.

BOTANICAL NAME	COMMON NAME	BROAD VEGETATION TYPES			
		1	2	3	4
Myrtaceae contd					
Lophostemon suaveolens	Swamp Turpentine	×	×	×	×
Melaleuca quinquenervia	Broad-leaved Paperbark	×	×	×	×
Pilidiostigma glabrum	Plum Myrtle	×			
Syzygium francisii	Giant Water Gum			×	
Portulacaceae					
Portulaca oleracea	Pigweed				×
Proteaceae					
Persoonia stradbrokensis	Geebung		×		
Stenocarpus sinuatus	Fire Wheel Tree			×	
Rhamnaceae					
Alphitonia excelsa	Red Ash			×	
Rubiaceae					
Pomax umbellata	Pomax		×		
Rutaceae					
**Citrus X limonia*	Rough Lemon			×	
Flindersia australis	Teak			×	
Flindersia bennettiana	Bennettís Ash			×	
Melicope elleryana	Pink Euodia	×		×	
Phebalium squameum	Satinwood	×	×		
Zieria smithii	Sandfly Zieria		×		
Sapindaceae					
Arytera dystylis	Twin-leaf Coogera			×	
Cupaniopsis anacardioides	Tuckeroo			×	
Guioa semiglauca	Guioa			×	
Jagera pseudorhus var *pseudorhus*	Foambark Tree			×	
Solanaceae					
Duboisia myoporoides	Soft Corkwood		×	×	
**Solanum mauritianum*	Tobacco Bush			×	×
Sterculiaceae					
Commersonia bartramii	Brush Kurrajong	×		×	
Ulmaceae					
Aphananthe philippinensis	Rough-leaved Elm			×	
Verbenaceae					
**Lantana camara*	Lantana	×		×	×
Vitaceae					
Cissus hypoglauca	Five-leaf Water Vine	×			

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 3b
Flora Species Recorded
Proposed Upgrade of the Pacific Highway, Brunswick to Yelgun

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APPENDIX 3b Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Key

* Introduced species

Conservation Status

ESP Threatened Species, as listed under the *Commonwealth Endangered Species Protection Act 1992*

- **E** Endangered Species
- **V** Vulnerable Species

R Rare Or Threatened Australian Plant (ROTAP) species (Briggs & Leigh 1996). ROTAP risk codes are defined in Section 4.3.2 - Table 4.5 of the working paper.

TSC Threatened species, as listed under the *NSW Threatened Species Conservation Act 1995.*

- **E** Endangered Species
- **V** Vulnerable Species

Broad Vegetation Types

1. Wet sclerophyll forest
2. Swamp sclerophyll forest
3. Rainforest
4. Disturbed regrowth/pasture

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
FILICOPSIDA								
Adiantaceae								
Adiantum hispidulum	Rough Maidenhair				×			
Aspleniaceae								
Asplenium australasicum	Bird's Nest Fern				×	×	×	
Blechnaceae								
Blechnum cartilagineum	Gristle Fern				×	×	×	
Blechnum indicum	Bungwal Fern					×		
Doodia aspera	Prickly Rasp Fern				×			
Cyatheaceae								
Cyathea australis	Rough Tree Fern				×			
Cyathea leichhardtiana	Prickly Tree Fern				×		×	
Davalliaceae								
Arthropteris tenella	-						×	
Dennstaedtiaceae								
Calochlaena dubia	Common Ground Fern				×	×		×
Hypolepis muelleri	Harsh Ground Fern					×		×
Pteridium esculentum	Bracken					×		×
Dryoptridaceae								
Arachnoides aristata	Prickly Shield Fern				×		×	
Lastreopsis acuminata	Shiny Shield Fern						×	
Lastreopsis decomposita	Trim Shield Fern						×	
Lastreopsis marginans	Blunt Shield Fern						×	
Pteridaceae								
Acrostichum speciosum	Mangrove Fern					×		
Polypodiaceae								
Platycerium bifurcatum subsp *bifurcatum*	Staghorn Fern				×	×		
Platycerium superbum	Elkhorn Fern					×		
Pyrrosia confluens	Felt Fern					×		
CONIFEROPSIDA								
Araucariaceae								
Araucaria cunninghamii	Hoop Pine				×		×	×

APPENDIX 3b cont Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
MAGNOLIOPSIDA - MONOCOTYLEDONS								
Amaryllidaceae								
Crinum pedunculatum	Swamp Lily					×		
Alocasia brisbanensis	Cunjevoi					×		×
Arecaceae								
Archontophoenix cunninghamiana	Bangalow Palm				×	×	×	
Calamus muelleri	Southern Lawyer Vine						×	
Livistona australis	Cabbage Tree Palm						×	
Asparagaceae								
* *Protasparagus plumosus*	Climbing Asparagus Fern							×
Asteliaceae								
Cordyline petiolaris	Large-leaved Cordyline				×		×	
Cordyline rubra	Small-leaved cordyline				×			
Commelinaceae								
Commelina cyanea	Scurvy Weed				×	×		
Pollia crispata	Pollia						×	
Cyperaceae								
Baumea articulata	-					×		
Baumea rubiginosa	-					×		
Carex maculata	-					×		
Cyperus lucidus	Sedge							
Cyperus polystachyos	Sedge							
Fimbristylis dichotoma								×
Gahnia aspera	Large-fruited Saw Sedge					×		
Gahnia clarkei	Tall Saw Sedge					×	×	
Schoenus brevifolius	-					×		
Dioscoraceae								
Dioscorea transversa	Native Yam				×		×	
Flagellariaceae								
Flagellaria indica	Whip Vine				×		×	
Juncaceae								
Juncus krausii subsp *australiensis*	Saltwater Rush-					×		
Juncus usitatus	Common Rush				×			×
Lomandraceae								
Lomandra longifolia	Spiny-headed Mat-Rush				×			×
Luzuriagaceae								
Geitonoplesium cymosum	Scrambling Lily				×		×	
Orchidaceae								
Cymbidium maddidum	-					×		
Cymbidium suave	-				×	×		
Phormiaceae								
Dianella caerulea	Blue Flax Lily				×			×
Poaceae								
* *Axonopus affinis*	Carpet Grass							×
Digitaria parviflora	Finger Grass					×		×
Echinochloa telmatiphila	Swamp Barnyard Grass							
Entolasia stricta					×		×	
Eriochloa pseudoacrotricha	Early Spring Grass							
Imperata cylindrica var *major*	Blady Grass							×
Ischaemum australe	-					×		
Leersia hexandra	-					×		
Melinis minutiflora	-							×
Oplismenus aemulus	-				×			×
Oplismenus imbecillis	-				×		×	
Ottochloa gracillima	-							
* *Paspalum conjugatum*	-							×
* *Paspalum dilatatum*	-							×
* *Paspalum urvillei*	-							×

APPENDIX 3b cont Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
Poaceae cont								
Phragmites australis	-					×		
Sacciolepis indica	Indian Cup Grass							×
* *Setaria sphacelata*	Pigeon Grass							×
Sporobolus elongatus	Slender Rat's Tail Grass							×
Sporobolus virginicus var *minor*	Rat's Tail Fescue						×	
Themeda australis	Kangaroo Grass							×
Smilacaceae								
Ripogonum album	Smooth Supplejack				×		×	
Ripogonum elseyanum	Hairy Supplejack				×		×	
Smilax australis	Barb-wire Vine				×		×	×
Uvulariaceae								
Tripladenia cunninghamii	-				×			
Zingiberaceae								
Alpinia caerulea	Native Ginger				×			
MAGNOLIOPSIDA - DICOTYLEDONS								
Acanthaceae								
Pseuderanthemum variabile	Blue Trumpet				×			
	-							
Aizoaceae	-							
Tetragonia tetragonioides	New Zealand Spinach					×		
Anacardiaceae								
Euroschinus falcata	Ribbonwood				×		×	
* *Mangifera indica*	Mango							×
* *Schinus terebinthifolia*	Pepper Tree					×		
Annonaceae								
Ancana stenopetala	-						×	
Polyalthia nitidissima	-						×	
Apocynaceae								
Alyxia ruscifolius	-				×			
Melodinus australis	Southern Melodinua				×		×	
Parsonsia straminea	Silkpod				×	×	×	
Parsonsia velutina	Hairy Silkpod						×	
Tabernaemontana pandacaqui	Banana Bush				×		×	×
Araliaceae								
Polyscias elegans	Celerywood				×		×	×
* *Schefflera actinophylla*	Umbrella Tree				×		×	×
Asclepiadaceae								
Hoya australis	-							
Marsdenia rostrata	Common Milk Vine				×			
Asteraceae								
* *Ageratina adenophora*	Crofton Weed				×	×		×
* *Ageratina riparia*	Mist Flower				×		×	×
* *Ageratum houstonianum*	Blue Goat Weed				×			
* *Baccharis halimifolia*	Groundsel Bush				×	×	×	×
* *Conyza bonariensis*	Fleabane				×			×
* *Cotula coronopifolia*	Water Buttons					×		
* *Hypochaeris radicata*	Catsear							×
Bignoniaceae								
Pandorea jasminoides	Bower Vine						×	
Burseraceae								
Canarium australasicum	-						×	
Capparaceae								
Capparis arborea	Native Caper				×		×	
Casuarinaceae								
Allocasuarina torulosa	Forest Oak				×			

APPENDIX 3b cont Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
Casuarinaceae cont								
Casuarina glauca	Swamp Oak				×	×		
Celastraceae								
Denhamia celastroides	Denhamia				×			
Chenopodiaceae								
Einadia hastata	Berry Saltbush					×		
Convolvulaceae								
* *Ipomoea cairica*	-					×		
Cunoniaceae								
Caldcluvia paniculosa	Corkwood				×		×	
Geissois benthamiana	Red Carabeen				×		×	×
Pseudoweinmannia lachnocarpa	Rose Marara						×	
Davidsoniaceae								
Davidsonia puriens subsp *jerseyana*	Davidson's Plum	E	2ECi	E	×			
Dilleniaceae								
Hibbertia scandens	Guinea Flower				×	×		×
Ebenaceae								
Diospyros fasciculosa	Grey Ebony						×	
Diospyros pentamera	Myrtle Ebony				×		×	
Elaeocarpaceae								
Elaeocarpus eumundi	Eumundi Quandong				×			
Elaeocarpus grandis	Blue Fig						×	
Elaeocarpus kirtonii	White Quandong						×	
Elaeocarpus reticulatus	Blue Berry ash				×			
Elaeocarpus obovatus	Hard Quandong				×		×	
Elaeocarpus williamsianus	Hairy Quandong	E	2ECi	E	×			
Sloanea australis	Maidens Blush				×		×	
Sloanea woollsii	Yellow Carabeen				×		×	
Epacridaceae								
Acrotriche aggregata	Shrub Honeypots				×			
Trochocarpa laurina	Bolwarra				×			
Escalloniaceae								
Quintinia verdonii	Grey Possumwood				×		×	
Euphorbiaceae								
Actephila lindleyi	Actephila				×		×	
Alchornea ilicifolia	NativeIHolly						×	
Bridelia exaltata	Brush Ironbark				×		×	
Cleistanthus cunninghamii	Cleistanthus						×	
Croton verreauxii	Native Cascarilla				×		×	
Drypetes australasica	Yellow Tulip				×		×	
Excoecaria agallocha	Milky Mangrove					×		
Glochidion ferdinandi var *ferdinandi*	Smooth Cheese Tree				×	×	×	×
Glochidion sumatranum	Umbrella Cheese Tree				×	×	×	×
Macaranga tanarius	Macaranga				×		×	×
Mallotus discolor	White Kamala				×		×	×
Mallotus philippensis	Red Kamala				×	×	×	×
Eupomatiaceae								
Eupomatia bennettiana	Small Bolwarra				×		×	
Eupomatia laurina	Bolwarra				×		×	×
Fabaceae: Caesalpinioidiae								
Caesalpinia scortechinii	Large Prickle Vine				×		×	×
Caesalpinia subtropica	Corky Prickle vine					×		
Senna pendula var. *glabrata*	Cassia						×	
Fabaceae: Faboideae								
Austrosteenisia blackii	Giant Bloodvine							×
Castanospermum australe	Blackbean						×	
Daviesia arborea	Tree Bitter Pea				×			
Desmodium rhytidophyllum	Tick Trefoil				×			
Hardenbergia violacea	False Sarsparilla				×			

APPENDIX 3b cont Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
Fabaceae: Faboideae cont								
Hovea acutifolia	Hovea					×		
Milletttia megeaperma	Native Wisteria						×	
Fabaceae: Mimosoideae								
Acacia aulocarpa var *aulocarpa*	Scrub Ironbark Wattle				×		×	×
Acacia bakeri	Marblewood		3VC		×		×	
Acacia melanoxylon	Blackwood				×	×	×	×
Archidendron grandiflorum	Laceflower Tree				×			
Archidendron muellerianum	Veiny Laceflower		3RCa		×		×	
Flacourtiaceae								
Xylosma terrae-reginae	Xylosma						×	
Lamiaceae								
Plectranthus parviflorus	Common Cockspur Flower							×
Lauraceae								
Beilschmiedia obtusifolia	Blunt-leaved Walnut						×	
* *Cinnamomum camphora*	Camphor Laurel				×		×	×
Cryptocarya foetida	Stinking Cryptocarya	V	3VCi	V	×		×	
Crytptocarya glaucescens	Jackwood				×		×	
Crytptocarya laevigata	Red-fruited Laurel						×	
Crytptocarya obovata	Pepperberry tree						×	
Crytptocarya microneura	Murrogun				×			
Crytptocarya triplinervis	Three-veined Laurel						×	
Endiandra compressa	White Bark						×	
Endiandra discolor	Domatia Tree				×	×	×	
Endiandra floydii	Crystal Creek Walnut	E	2VC-	E	×		×	
Endiandra globosa	Black Walnut		2RC-		×		×	
Endiandra muelleri subsp *bracteata*	Green-leaved Rose Walnut			E	×		×	
Endiandra pubens	Hairy Walnut				×		×	
Litsea australis	Brown Bollygum				×		×	×
Neolitsea australiensis	Green Bollygum						×	
Neolitsea dealbata	White Bollygum				×		×	
Lobeliaceae								
Lobelia trigonocaulis	Forest Lobelia				×			
Pratia purpurascens	Purple Pratia					×		×
Loranthaceae								
Amyema cambagei	Mistletoe					×		
Amyema congener subsp *congeneri*	Mistletoe				×			
Meliaceae								
Dysoxylum mollissimum	Red Bean				×		×	
Synoum glandulosum	Scentless Rosewood				×		×	×
Menispermaceae								
Carronia multisepala	Carronia						×	
Monimiaceae								
Doryphora sassafras	Sassafras				×		×	
Wilkiea austroqueenslandica	Smooth Wilkiea						×	
Wilkiea huegeliana	Veiny Wilkiea				×		×	
Moraceae								
Ficus coronata	Creek Sandpaper Fig				×		×	
Ficus fraseri	Sandpaper Fig				×		×	
Ficus macrophylla subsp *macrophylla*	Moreton Bay Fig						×	
Ficus virens var *sublanceolata*	White Fig				×			
Ficus watkinsiana	Strangler Fig						×	
Maclura cochinchinensis	Orange Thorn				×		×	×
Malaisia scandens	Burny Vine				×			
Streblus brunonianus	Whalebone Tree				×		×	
Myoporaceae								
Myoporum acuminatum	Coast Boobialla					×		
Myrsinaceae								
Aegiceras corniculatum	River Mangrove					×	×	
Embelia australiana	Embelia				×			
Rapanea howittiana	Brush Muttonwood				×			

APPENDIX 3b cont Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
Myrsinaceae cont								
Rapanea variabilis	Muttonwood				×			
Myrtaceae								
Acmena ingens	Red Apple						×	
Acmena smithii	Lilly Pilly				×		×	
Myrtaceae contd								
Archirhodomyrtus beckleri	Rose Myrtle				×		×	×
Austromyrtus hillii	Scaly Myrtle						×	
Austromyrtus dulcis	Midgenberry				×			×
Corymbia intermedia	Pink Bloodwood				×			×
Eucalyptus carnea	Broad-leaved White Mahogany				×			
Eucalyptus grandis	Flooded Gum				×			
Eucalyptus microcorys	Tallow-wood				×			
Eucalyptus pilularis	Blackbutt				×			×
Eucalyptus robusta	Swamp Mahogany					×		
Eucalyptus siderophloia	Broad-leaved Ironbark				×			×
Lophostemon confertus	Brush Box				×		×	×
Lophostemon suaveolens	Swamp Turpentine				×	×	×	×
Melaleuca quinquenervia	Broad-leaved Paperbark					×		
Pilidiostigma glabrum	Plum Myrtle				×		×	×
* *Psidium guajava*	Guava							×
Rhodamnia rubescens	Scrub Turpentine				×			
Rhodomyrtus psidioides	Native Guava				×			×
Syzygium australe	Brush Cherry						×	
Syzygium francisii	Giant Water Gum						×	
Syzygium hodgkinsoniae	Red Lilly Pilly	V	3VC	V	×			
Syzygium luehmannii	Riberry				×		×	
Syzygium moorei	Coolamon	V	2VCi	V			×	
Syzygium oleosum	Blue Lilly Pilly				×			
Oleaceae								
* *Ligustrum lucidum*	Privet						×	
Notelaea longifolia	Mock-olive				×			
Pittosporaceae								
Citriobatus pauciflorus	Orange Thorn				×		×	
Pittosporum undulatum	Brush Daphne				×		×	×
Polygonaceae								
Persicaria strigosa	Water Pepper				×			
Proteaceae								
Grevillea hilliana	White Yiel Yiel						×	
Helicia ferruginea	Rusty Helicia						×	
Macadamia tetraphylla	Queensland Nut	V	2VC-	V			×	
Persoonia stradbrokensis	Swamp Hakea				×			
Isopogon petiolaris	Drumstick							
Rhamnaceae								
Alphitonia excelsa	Alphitona				×		×	×
Rosaceae								
Rubus hillii	Molucca Bramble				×		×	×
Rubus rosifolius	Rose-leaf Bramble				×		×	×
Rubiaceae								
Canthium coprosmoides	Coast Canthium				×		×	
Coelospermum paniculatum	Coelospermum						×	
Morinda jasminoides	Morinda				×		×	
Randia benthamiana	Native Gardenia						×	
Randia moorei	Spiny Gardenia	E	3ECi	E			×	
Rutaceae								
Flindersia australis	Teak				×		×	
Flindersia bennettiana	Bennett's Ash				×		×	
Flindersia schottiana	Cudgerie				×		×	
Medicosma cunninghamii	Medicosma						×	
Melicope elleryana	Pink Euodia				×		×	
Melicope vitiflora	Northern Euodia						×	
Microcitrus australasica var *australasica*	Finger Lime						×	
Pentaceras australe	Crows Ash				×		×	

APPENDIX 3b cont Flora species recorded in the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Botanical Name	Common Name	Status			Broad Vegetation Types			
		ESP	R	TSC	1	2	3	4
Rutaceae cont								
Zieria smithii	Sandfly Zieria				×			
Santalaceae								
Exocarpos latifolius								
Sapindaceae								
Arytera dystylis	Twin-leaf Coogera						×	
Cupaniopsis anacardioides	Tuckeroo				×		×	×
Cupaniopsis newmanii	Long-leaved Tuckeroo		2RC-		×		×	
Sapindaceae								
Elattostachys nervosa	Green Tamarind							×
Guioa semiglauca	Guioa				×		×	×
Jagera pseudorhus var *pseudorhus*	Foambark Tree				×		×	×
Mischocarpus pyriformis subsp *pyriformis*	Yellow Pear Fruit				×		×	
Sarcopteryx stipata	Steelwood				×		×	×
Toechima dasyrrhache	Blunt-leaved Steelwood				×		×	
Sapotaceae								
Planchonella australis	Black Apple						×	
Planchonella chartacea	Thin-leaved Coondoo				×		×	
Planchonella laurifolia	Blush Coondoo				×		×	
Solanaceae								
Duboisia myoporoides	Soft Corkwood				×	×	×	
* *Solanum capsicoides*	Devil's Apple							×
* *Solanum mauritianum*	Tobacco Bush				×	×	×	×
Sterculiaceae								
Commersonia bartramii	Brush Kurrajong				×	×	×	×
Heritiera trifoliolata	White Booyong						×	
Symplocaceae								
Symplocos stawellii	White Hazelwood						×	
Ulmaceae								
Aphanthe philippensis	Rough-leaved Elm				×		×	
Trema aspera	Poison Peach				×		×	×
Verbenaceae								
Gmelina leichhardtii	White Beech				×		×	
* *Lantana camara*	Lantana				×	×	×	×
Vitaceae								
Cissus antarctica	Water Vine				×		×	×
Cissus hypoglauca	5-leaved Water Vine				×		×	×

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 4
Fauna Species Recorded in the Study Area

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APPENDIX 4 Fauna species recorded during the field surveys for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun, and during previous investigations in the general vicinity.

Key

* Introduced species

? tentative identification

Conservation Status

ESP Species listed under the *Commonwealth Endangered Species Protection Act 1992*

- **E** Endangered Species
- **V** Vulnerable Species

TSC Species listed under the *NSW Threatened Species Conservation Act 1995*

- **E** Endangered Species
- **V** Vulnerable Species

Records

1 Species recorded within the study area for the proposed duplication of the Brunswick Heads Bypass.

2 Species recorded within the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

A Records of fauna from previous investigations in the general locality and wider surrounding area (see key at end of fauna list).

COMMON NAME	SCIENTIFIC NAME	ESP	TSC	1	2	A
AVIFAUNA						
Megapodidae						
Australian Brush Turkey	*Alectura lathami*				×	D, F, G, K
Phasianidae						
Stubble Quail	*Coturnix pectoralis*					B, D
Brown Quail	*Coturnix ypsilophora*					B, D, G, H, I, K
Anseranatidae						
Magpie Goose	*Anseranas semipalmata*		V			B, C, D
Anatidae						
Plumed Whistling-Duck	*Dendrocygna eytoni*					D, F
Wandering Whistling-Duck	*Dendrocygna arcuata*					D
Freckled Duck	*Stictonetta naevosa*		V			C
Black Swan	*Cygnus atratus*					B, D, G
Australian Wood Duck	*Chenonetta jubata*					B, D, F, G, H, K
*Mallard	*Anas platyrhynchos*					B, D
Pacific Black Duck	*Anas superciliosa*			×		B, D, E, F, G, H, I, K
Grey Teal	*Anas gracilis*					B, D, F, G
Chestnut Teal	*Anas castanea*					B, D
Hardhead	*Aythya australis*					B, D, H
Podicipedidae						
Australasian Grebe	*Tachybaptus novaehollandiae*					B, D, G, H
Hoary-headed Grebe	*Poliocephalus poliocephalus*					B, D
Procellariidae						
White-chinned Petrel	*Procellaria aequinoctialis*					B
Gould's Petrel	*Pterodroma leucoptera*	V	V			C
Black-winged Petrel	*Pterodroma nigripennis*		V			C
Fleshy-footed Shearwater	*Puffinus carneipes*		V			B
Wedge-tailed Shearwater	*Puffinus pacificus*					B, D
Short-tailed Shearwater	*Puffinus tenuirostris*					B, D
Fluttering Shearwater	*Puffinus gavia*					D

APPENDIX 4 cont Fauna species recorded during the field surveys for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun, and during previous investigations in the general vicinity.

COMMON NAME	SCIENTIFIC NAME	ESP	TSC	1	2	A
Diomedeidae						
Wandering Albatross	*Diomedea epomophora*	V	V			B
Phaethontidae						
Red-tailed Tropicbird	*Phaethon rubricauda*		V			C
Sulidae						
Australasian Gannet	*Morus serrator*					B, D
Anhingidae						
Darter	*Anhinga melanogaster*				×	B, D, E, F, H
Phalacrocoracidae						
Little Pied Cormorant	*Phalacrocorax melanoleucos*				×	B, D, E, F, G, H, K
Pied Cormorant	*Phalacrocorax varius*					B, D, E, K
Little Black Cormorant	*Phalacrocorax sulcirostris*				×	B, D, E, H, K
Great Cormorant	*Phalacrocorax carbo*			×	×	B, D, E, G, K
Pelecanidae						
Australian Pelican	*Pelecanus conspicillatus*				×	B, D, G, K
Fregatidae						
Lesser Frigatebird	*Fregata ariel*					D
Ardeidae						
White-faced Heron	*Egretta novaehollandiae*				×	B, D, E, F, G, H, I, K
Little Egret	*Egretta garzetta*				×	B, D, E, G, K
Eastern Reef Egret	*Egretta sacra*					B, D, K
White-necked Heron	*Ardea pacifica*					B, D, E, F, H, K
Great Egret	*Ardea alba*					B, D, E, H, I, K
Intermediate Egret	*Ardea intermedia*					B, D, H, K
Cattle Egret	*Ardeola ibis*					B, D, E, G, H, K
Striated Heron	*Butorides striatus*				×	B, D, E, H
Nankeen Night Heron	*Nycticorax caledonicus*					B, D
Black Bittern	*Ixobrychus flavicollis*		V			B, C, D, L
Australasian Bittern	*Botaurus poiciloptilus*		V			L
Threskiornithidae						
Glossy Ibis	*Plegadis falcinellus*					B, D
Australian White Ibis	*Threskiornis molucca*				×	B, D, E, F, G, H, I, K
Straw-necked Ibis	*Threskiornis spinicollis*					B, D, E, F, H, K
Royal Spoonbill	*Platalea regia*					B, D, E, G, H, K
Yellow-billed Spoonbill	*Platalea flavipes*					B, D, G
Ciconiidae						
Black-necked Stork	*Ephippiorhynchus asiaticus*		V			B, C, D, H
Accipitridae						
Osprey	*Pandion haliaetus*		V		×	B, C, D, E, F, H, I, K, L
Crested Hawk	*Aviceda subcristata*				×	B, D, E, F, I, K
Black-shouldered Kite	*Elanus axillaris*					B, D, G, H, I, K
Square-tailed Kite	*Lophoictinia isura*		V			L
Whistling Kite	*Haliastur sphenurus*				×	B, D, E, F, G, H, I, K
Brahminy Kite	*Haliastur indus*				×	B, D, E, F, H, I, K
White-bellied Sea-Eagle	*Haliaeetus leucogaster*					B, D, E, F, G, H, K
Spotted Harrier	*Circus assimilis*					B
Swamp Harrier	*Circus approximans*					B, D, H, I
Brown Goshawk	*Accipiter fasciatus*					B, D, G, H, I, K
Grey Goshawk	*Accipiter novachollandiae*					B, D, E, I, K
Collared Sparrowhawk	*Accipiter cirrhocephalus*					B, D, I
Red Goshawk	*Erythrotriorchis radiatus*	V	E			C
Wedge-tailed Eagle	*Aquila audax*					B, D, G, H, K

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Accipitridae cont						
Little Eagle	*Hieraaetus morphnoides*					D, E, G
Falconidae						
Brown Falcon	*Falco berigora*					B, D, G
	Falco longipennis					D
Black Falcon	*Falco subniger*					B
Peregrine Falcon	*Falco peregrinus*					D
Nankeen Kestrel	*Falco cenchroides*					B, D, F, G, I
Gruidae						
Brolga	*Grus rubicundus*		V			B, C, D, L
Rallidae						
Buff-banded Rail	*Rallus philippensis*					B, D, K
Lewin's Rail	*Rallus pectoralis*					E, I
Bush-hen	*Amaurornis olivaceus*		V			C, F, L
Baillon's Crake	*Porzana pusilla*					B, D
Purple Swamphen	*Porphyrio porphyrio*					B, D, F, G, H, K
Dusky Moorhen	*Gallinula tenebrosa*					B, D, F, G, K
Eurasian Coot	*Fulica atra*					B, D, F, G
Turnicidae						
Little Button-quail	*Turnix velox*					B
Scolopacidae						
Latham's Snipe	*Gallinago hardwickii*					B, D, E, H
Bar-tailed Godwit	*Limosa lapponica*				×	B, D
Whimbrel	*Numenius phaeopus*				×	B, D, F, H, I, K
Eastern Curlew	*Numenius madagascariensis*				×	B, D, F, H
Marsh Sandpiper	*Tringa stagnatilis*					D
Common Greenshank	*Tringa nebularia*					B, D, H, K
Terek Sandpiper	*Xenus terek*		V			D
Common Sandpiper	*Actitis hypoleucos*				×	D
Grey-tailed Tattler	*Heteroscelus brevipes*					B, D, H, K
Wandering Tattler	*Heteroscelus incana*					B, D
Ruddy Turnstone	*Arenaria interpres*				×	B, D
Great Knot	*Calidris tenuirostris*		V			C
Red Knot	*Calidris canutus*					B
Sanderling	*Calidris alba*		V			B
Red-necked Stint	*Calidris ruficollis*					B, D
Sharp-tailed Sandpiper	*Calidris acuminata*					B, D
Curlew Sandpiper	*Calidris ferruginea*					D
Jacanidae						
Comb-crested Jacana	*Irediparra gallinacea*		V			B, C, D, G, L
Burhinidae						
Bush Stone-curlew	*Burhinus grallarius*		E			C, D
Beach Stone-curlew	*Esacus neglectus*		E			B, C
Haematopodidae						
Pied Oystercatcher	*Haematopus longirostris*		V		×	B, C, D, E, J, K
Sooty Oystercatcher	*Haematopus fuliginosus*		V			C, D
Recurvirostridae						
Black-winged Stilt	*Himantopus himantopus*					B, D, E
Charadriidae						
Pacific Golden Plover	*Pluvialis fulva*					B, D, H
Red-capped Plover	*Charadrius ruficapillus*					B, D, H
Double-banded Plover	*Charadrius bicinctus*					B, D
Lesser Sand Plover	*Charadrius mongolus*		V			B, D

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Charadriidae cont						
Greater Sand Plover	*Charadrius leschenaultii*		V			D
Black-fronted Plover	*Elseyornis melanops*					B, D, E, F, G, H
Red-kneed Dotterel	*Erythrogonys cinctus*					D
Masked Lapwing	*Vanellus miles*				×	B, D, E, F, G, H, K
Laridae						
Arctic Jaeger	*Stercorarius parasiticus*					D
Silver Gull	*Larus novaehollandiae*				×	B, D, E, F, G, H, K
Whiskered Tern	*Chlidonias hybrida*					B, D
Gull-billed Tern	*Sterna nilotica*					B, D
Caspian Tern	*Sterna caspia*					B, D
Sooty Tern	*Sterna fuscata*					C
Common Tern	*Sterna hirundo*				×	B, D, K
White-fronted Tern	*Sterna striata*					B
Little Tern	*Sterna albifrons*	E	E			B, C, D, K
Crested Tern	*Sterna bergii*				×	B, D, E, F, H, K
Roseate Tern	*Sterna dougallii*				×	
Lesser Crested Tern	*Sterna bengalensis*					D
Common Noddy	*Anous stolidus*					D
Columbidae						
* Rock Dove	*Columba livia*					B, D, G, I
Superb Fruit-Dove	*Ptilinopus superbus*		V			C
Rose-crowned Fruit-Dove	*Ptilinopus regina*		V			C, D, L
Wompoo Fruit-Dove	*Ptilinopus magnificus*		V			B, C, D, G, L
Topknot Pigeon	*Lopholaimus antarcticus*					B, D, H, K
White-headed Pigeon	*Columba leucomela*				×	B, D, E, F, G, I, K
* Spotted Turtle-Dove	*Streptopelia chinensis*					B, D, F, G
Brown Cuckoo-Dove	*Macropygia amboinensis*			×	×	B, D, E, F, G, I
Peaceful Dove	*Geopelia placida*			×	×	B, D, E, F, H, I
Diamond Dove	*Geopelia cuneata*					B
Bar-shouldered Dove	*Geopelia humeralis*					B, D, E, F, G, H, I, K
Emerald Dove	*Chalcophaps indica*			×	×	B, D, E, F, G, H, I
Common Bronzewing	*Phaps chalcoptera*					B, D, G
Crested Pigeon	*Ocyphaps lophotes*				×	B, D, E, F, G, H, I, K
Wonga Pigeon	*Leucosarcia melanoleuca*					B
Cacatuidae						
Red-tailed Black Cockatoo	*Calyptorhynchus banskii*		V			C
Glossy Black Cockatoo	*Calyptorhynchus lathami*		V			C, D, L
Yellow-tailed Black Cockatoo	*Calyptorhynchus funereus*					D, K
Galah	*Cacatua roseicapilla*			×	×	B, D, E, F, G, K
Little Corella	*Cacatua sanguinea*				×	D
Sulphur-crested Cockatoo	*Cacatua galerita*			×		D, E, F, G, K
Psittacidae						
Rainbow Lorikeet	*Trichoglossus haematodus*					B, D, E, F, G, H, I, K
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*			×	×	B, D, E, F, G, H, I, K
Little Lorikeet	*Glossopsitta pusilla*					B, D
Double-eyed Fig-Parrot	*Cyclopsitta diophthalma*	E	E			C
Australian King-Parrot	*Alisterus scapularis*					D, F, G
Swift Parrot	*Lathamus discolor*	V	V			C, D
Crimson Rosella	*Platycercus elegans*					B, D, G, H
Eastern Rosella	*Platycercus eximius*			×		B, D, E, F, H, I, K
Cuculidae						
Pallid Cuckoo	*Cuculus pallidus*					D, F, G
Brush Cuckoo	*Cuculus variolosus*				×	B, D, E, F, I, K
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			×	×	B, D, E, F, H, I
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*			×	×	B, D, I

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Cuculidae cont						
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*					B, D, E, I
Little Bronze-Cuckoo	*Chrysococcyx minutillus*				×	D
Common Koel	*Eudynamis scolopacea*				×	B, D, F, K
Channel-billed Cuckoo	*Scythrops novaehollandiae*					D, G
Centropodidae						
Pheasant Coucal	*Centropus phasianinus*			×	×	K
Strigidae						
Powerful Owl	*Ninox strenua*		V			G
Southern Boobook	*Ninox noveseelandiae*				×	B, D, E, F, G, K
Tytonidae						
Barn Owl	*Tyto alba*					D, K
Masked Owl	*Tyto novaehollandiae*		V			C, L
Grass Owl	*Tyto capensis*		V			C, E, L
Sooty Owl	*Tyto tenebricosa*		V			C
Podargidae						
Tawny Frogmouth	*Podargus strigoides*				×	B, D, E, F, G, H, K
Marbled Frogmouth	*Podargus ocellatus*		V			C
Caprimulgidae						
White-throated Nightjar	*Eurostopodus mystacalis*					E, H, I, K
Aegothelidae						
Australian Owlet-nightjar	*Aegotheles cristatus*					E, F
Apodidae						
White-rumped Swiftlet	*Collocalia spodiopygius*					D
White-throated Needletail	*Hirundapus caudacutus*			×	×	B, D, F, H, I
Fork-tailed Swift	*Apus pacificus*					B, D
Azure Kingfisher	*Alcedo azurea*					B, D, E, F, G, H, I, K
Little Kingfisher	*Alcedo pusilla*					B
Halcyonidae						
Kookaburra	*Dacelo novaeguineae*			×	×	B, D, E, F, G, H, I, K
Forest Kingfisher	*Todiramphus macleayii*					B, D, E, F, G, H
Sacred Kingfisher	*Todiramphus sancta*			×		B, D, H, I, K
Collared Kingfisher	*Todiramphus chloris*		V			C, D, F
Meropidae						
Rainbow Bee-eater	*Merops ornatus*			×		B, D, E, F, G, H, I, K
Coraciidae						
Dollarbird	*Eurystomus orientalis*			×	×	B, D, E, F, G, H, I, K
Pittidae						
Noisy Pitta	*Pitta versicolor*					B, D, E, F
Menuridae						
Albert's Lyrebird	*Menura alberti*		V			C
Superb Lyrebird	*Menura novaehollandiae*					G
Climacteridae						
White-throated Treecreeper	*Cormobates leucophaea*				×	D, E, F, G, H
Maluridae						
Superb Fairy-wren	*Malurus cyaneus*				×	B, D, E, F, G, H, I, K
Variegated Fairy-wren	*Malurus lamberti*			×	×	B, D, E, F, G, H, I
Red-backed Fairy-wren	*Malurus melanocephalus*			×		B, D, E, F, H, I, K
Southern Emu-wren	*Stipiturus malachurus*					B, D, I

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Pardolotidae						
Spotted Pardalote	*Pardalotus punctatus*					B, D, E, G, H, I
Striated Pardalote	*Pardalotus striatus*					B, D, E, I
Large-billed Scrubwren	*Sericornis magnirostris*			×	×	B, D, F, G, H, I
Yellow-throated Scrubwren	*Sericornis citreogularis*					F
White-browed Scrubwren	*Sericornis frontalis*			×	×	B, D, E, F, G, H, I, K
Brown Gerygone	*Gerygone mouki*				×	B, D, F, I, K
Mangrove Gerygone	*Gerygone levigaster*				×	B, D, E, I
White-throated Gerygone	*Gerygone olivacea*			×		B, D, E, H, K
Brown Thornbill	*Acanthiza pusilla*			×	×	B, D, E, F, G, H, I, K
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*					B, D
Yellow Thornbill	*Acanthiza nana*					B, D, G
Striated Thornbill	*Acanthiza lineata*				×	B, D, F
Meliphagidae						
Red Wattlebird	*Anthochaera carunculata*					D
Little Wattlebird	*Anthochaera chrysoptera*			×		B, D, E, F, G, H, I, K
Striped Honeyeater	*Plectorhyncha lanceolata*					D, E
Noisy Friarbird	*Philemon corniculatus*				×	B, D, E, F, G, H, I
Little Friarbird	*Philemon citreogularis*					B, D, F, H, I
Regent Honeyeater	*Xanthomyza phrygia*	E	E			L
Blue-faced Honeyeater	*Entomyzon cyanotis*					B, D, E, F, K
Lewin's Honeyeater	*Meliphaga lewinii*			×	×	B, D, E, F, G, H, I, K
Noisy Miner	*Manorina melanocephala*			×	×	B, D, E, F, G, H, K
Yellow-faced Honeyeater	*Lichenostomus chrysops*				×	B, D, E, F, G, H, I
Mangrove Honeyeater	*Lichenostomus fasciogularis*		E			C, F
White-gaped Honeyeater	*Lichenostomus unicolor*					H
White-eared Honeyeater	*Lichenostomus leucotis*					B, D
Brown-headed Honeyeater	*Melithreptus brevirostris*					D
White-throated Honeyeater	*Melithreptus albogularis*					B, D, H
White-naped Honeyeater	*Melithreptus lunatus*					B, D
Brown Honeyeater	*Lichmera indistincta*			×		B, D, E, F, G, H, I, K
New Holland Honeyeater	*Phylidonyris novaehollandiae*				×	B
White-cheeked Honeyeater	*Phylidonyris nigra*			×		B, D, E, G, H, I, K
Eastern Spinebill	*Acanthorhynchus tenuirostris*					B, D, E, G, H, I
Scarlet Honeyeater	*Myzomela sanguinolenta*				×	B, D, E, H, I
Petroicidae						
Rose Robin	*Petroica rosea*					B, D
Eastern Yellow Robin	*Eopsaltria australis*				×	B, D, E, F, G, H, I
Jacky Winter	*Microeca leucophaea*					B
Pale-yellow Robin	*Tregellasia capito*				×	B, D
Orthonychidae						
Logrunner	*Orthonyx temminckii*					D
Pomatostomidae						
Grey-crowned Babbler	*Pomatostomus temporalis*					D
Cinclosomatidae						
Eastern Whipbird	*Psophodes olivaceus*			×	×	B, D, E, F, G, H, I, K
Neosittidae						
Varied Sittella	*Daphoenositta chrysoptera*					D, G
Pachycephalidae						
Olive Whistler	*Pachycephala olivacea*		V			C
Golden Whistler	*Pachycephala pectoralis*					B, D, E, F, G, H, I
Rufous Whistler	*Pachycephala rufiventris*				×	B, D, E, F, G, H, I
Little Shrike-thrush	*Colluricincla megarhyncha*					B, D, E, F, I
Grey Shrike-thrush	*Colluricincla harmonica*			×		B, D, E, F, G, H, I

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Dicruridae						
Black-faced Monarch	*Monarcha melanopsis*				×	B, D, F, H, I
Spectacled Monarch	*Monarcha trivirgatus*				×	D, H, I
White-eared Monarch	*Monarcha leucotis*		V			B, C, D, L
Leaden Flycatcher	*Myiagra rubecula*				×	B, D, E, F, G, H, I
Restless Flycatcher	*Myiagra inquieta*					B, D
Magpie-lark	*Grallina cyanoleuca*				×	B, D, E, F, H, I, K
Rufous Fantail	*Rhipidura rufifrons*				×	B, D, E, F, G, H, I
Grey Fantail	*Rhipidura fuliginosa*			×		B, D, E, F, G, H, I, K
Willie Wagtail	*Rhipidura leucophrys*			×		B, D, E, F, G, H, I, K
Spangled Drongo	*Dicrurus bracteatus*			×		B, D, E, F, G, H, I, K
Campephagidae						
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			×	×	B, D, E, F, G, H, I, K
White-bellied Cuckoo-shrike	*Coracina papuensis*					B, D
Barred Cuckoo-shrike	*Coracina lineata*		V			C, D
Cicadabird	*Coracina tenuirostris*				×	B, D, F, H, I
White-winged Triller	*Lalage sueurii*					D
Varied Triller	*Lalage leucomela*				×	B, D, E, F, G, H, I
Oriolidae						
Olive-backed Oriole	*Oriolus sagittatus*				×	B, D, E, F, G, H, I
Figbird	*Sphecotheres viridis*				×	B, D, E, F, G, H, K
Artamidae						
White-breasted Woodswallow	*Artamus leucorhynchus*				×	B, D, F, G, H, I, K
White-browed Woodswallow	*Artamus superciliosus*					B, E
Dusky Woodswallow	*Artamus cyanopterus*					B, K
Grey Butcherbird	*Cracticus torquatus*			×	×	B, D, E, F, H, I
Pied Butcherbird	*Cracticus nigrogularis*			×	×	B, D, E, F, G, H, I, K
Australian Magpie	*Gymnorhina tibicen*				×	B, D, E, F, G, H, K
Pied Currawong	*Strepera graculina*			×	×	B, D, E, F, G, H, I, K
Corvidae						
Australian Raven	*Corvus coronoides*				×	B, D
Torresian Crow	*Corvus orru*			×	×	B, D, E, F, G, H, I, K
Ptilonorhynchidae						
Satin Bowerbird	*Ptilonorhynchus violaceus*					B, D
Regent Bowerbird	*Sericulus chrysocephalus*					B, D, I
Green Catbird	*Ailuroedus crassirostris*					B, D, G
Motacillidae						
Richard's Pipit	*Anthus novaeseelandiae*					B, D, E, G, H, K
Passeridae						
* House Sparrow	*Passer domesticus*					B, D, G, H
Red-browed Finch	*Neochmia temporalis*					B, D, E, F, G, H, I, K
Double-barred Finch	*Taeniopygia bichenovii*					B, D, H, I
Chestnut-breasted Mannikin	*Lonchura castaneothorax*					B, D, F
* Nutmeg Mannikin	*Lonchura punctulata*					B
Dicaeidae						
Mistletoebird	*Dicaeum hirundinaceum*			×		B, D, F, G, H, I
Hirundinidae						
White-backed Swallow	*Cheramoeca leucosternus*					B
Welcome Swallow	*Hirundo neoxena*				×	B, D, E, F, G, H, I, K
Tree Martin	*Hirundo nigricans*					B, D, E, H, I
Fairy Martin	*Hirundo ariel*				×	B, D, F, G, I, K
Sylviidae						
Clamorous Reed-Warbler	*Acrocephlus stentoreus*					B, D, G

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Sylviidae cont						
Tawny Grassbird	*Megalurus timoriensis*					B, D, E, G, H, I
Little Grassbird	*Megalurus gramineus*					B, D, I
Golden-headed Cisticola	*Cisticola exilis*					B, D, E, F, G, H, I
Brown Songlark	*Cinclorhamphus cruralis*					B
Zosteropidae						
Silvereye	*Zosterops lateralis*			×	×	B, D, E, F, G, H, I
Muscicapidae						
Russet-tailed Thrush	*Zoothera heinei*					B
Sturnidae						
* Common Starling	*Sturnus vulgaris*					B, D
MAMMALS						
Ornithorhynchidae						
Platypus	*Ornithorhynchus anatinus*					G
Tachyglossidae						
Short-beaked Echidna	*Tachyglossus aculeatus*				×	E, F, G, K
Dasyuridae						
Brown Antechinus	*Antechinus stuartii*				×	G
Brush-tailed Phascogale	*Phascogale tapoatafa*		V			C
Common Dunnart	*Sminthopsis murina*					G, I
Common Planigale	*Planigale maculata*		V			C, I
Peramelidae						
Northern Brown Bandicoot	*Isoodon macrourus*			×	×	G, H, I, K
Long-nosed Bandicoot	*Perameles nasuta*				×	C, E, F, K
Phascolarctidae						
Koala	*Phascolarctos cinereus*		V		×	C, E, F, G, H, J, K, L
Petauridae						
Sugar Glider	*Petaurus breviceps*					E, F, G, K
Squirrel Gider	*Petaurus norfolcensis*		V	×		C
Pseudocheiridae						
Greater Glider	*Petauroides volans*					G
Common Ringtail Possum	*Pseudocheirus peregrinus*			×	×	E, F, G, K
Acrobatidae						
Feathertail Glider	*Acrobates pygmaeus*				×	G
Phalangeridae						
Common Brush-tailed Possum	*Trichosurus vulpecula*					K
Mountain Brush-tailed Possum	*Trichosurus caninus*				×	E, G, H, I, K
Potoroidae						
Long-nosed Potoroo	*Potorous tridactylus*		V			C, E, G, L
Macropodidae						
Red-necked Wallaby	*Macropus rufogriseus*			×		G
Swamp Wallaby	*Wallabia bicolor*			×	×	E, F, G, H, I, K
Pteropodidae						
Queensland Blossom Bat	*Syconycteris australis*		V	×	×	C, E, G, H, L
Black Flying-fox	*Pteropus alecto*		V			C, K, L
Grey-headed Flying-fox	*Pteropus poliocephalis*			×	×	E, F, H, K
Emballonuridae						
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*		V			C

APPENDIX 4 cont Fauna species recorded during the field surveys for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun, and during previous investigations in the general vicinity.

COMMON NAME	SCIENTIFIC NAME	ESP	TSC	1	2	A
Molossidae						
Eastern Freetail-bat	*Mormopterus norfolkensis*		V			C
Vespertilionidae						
Little Bent-wing Bat	*Miniopterus australis*		V		×	C, E, G, L
Eastern Long-eared Bat	*Nyctophilus bifax*		V	×	×	C, E, G, L
Lesser Long-eared Bat	*Nyctophilus geoffroyi*					K
Gould's Long-eared Bat	*Nyctophilus gouldi*					G
Large Pied Bat	*Chalinolobus dwyeri*		V			C
Gould's Wattled Bat	*Chalinolobus gouldii*					G, K
Chocolate Wattled Bat	*Chalinolobus morio*					E
Large-footed Myotis	*Myotis adversus*		V			C
Greater Broad-nosed Bat	*Scoteanax rueppellii*		V	?		C, E
Eastern Broad-nosed Bat	*Scotorepens orion*				×	E, G
Eastern Forest Bat	*Vespadelus pumilus*				×	E
Little Forest Bat	*Vespadelus vulturnus*					G
Muridae						
Bush Rat	*Rattus fuscipes*			×	×	E, F, H, I, K
Swamp Rat	*Rattus lutreolus*				×	E, F, H, I
Water Rat	*Hydromys chrysogaster*					G
Fawn-footed Melomys	*Melomys cervinipes*				×	F, G
Grassland Melomys	*Melomys burtoni*					E, F, H, I, K
Introduced Mammals						
* Cat	*Felis catus*				×	
* Black Rat	*Rattus rattus*				×	F, G, H, I
* House Mouse	*Mus muculus*			×		G, H, I
* Rabbit	*Oryctolagus cuniculus*					G
* Brown Hare	*Lepus capensis*					H
* Feral Dog	*Canis familliaris*					E, F, G
* Fox	*Vulpes vulpes*			×		E, F, G
* Feral Cat	*Felis catus*					E, F, G
REPTILES						
Chelidae						
Eastern Long-necked Turtle	*Chelodina longicollis*					G
Saw-shelled Turtle	*Elseya latisternum*					G
Brisbane Short-necked Turtle	*Emydura signata*					K
Pygopodae						
Common Scaly-foot	*Pygopus lepidopodus*				×	I, K
Agamidae						
Jacky Lizard	*Amphibolorus noddi*					G
Eastern Water Dragon	*Physignathus lesueurii*			×	×	E, F, G, H, K
Bearded Dragon	*Pogona barbata*				×	G, K
Varanidae						
Lace Monitor	*Varanus varius*				×	E, F, G, I, K
Scincidae						
Wall Lizard	*Cryptoblepharus virgatus*				×	G
Striped Skink	*Ctenotus robustus*					G, H, I, K
Copper-tailed Skink	*Ctenotus taeniolatus*					H
Land Mullet	*Egernia major*				×	G, K
Black Crevice-skink	*Egernia saxatilis*					G
White's Rock-skink	*Egernia whitii*					G
Eastern Water Skink	*Eulamprus quoyii*					G, H, I
Barred-sided Skink	*Eulamprus tenuis*				×	F
Grass Skink	*Lampropholis delicata*					E, F, G, H, I

APPENDIX 4 cont Fauna species recorded during the field surveys for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun, and during previous investigations in the general vicinity.

COMMON NAME	SCIENTIFIC NAME	ESP	TSC	1	2	A
Scincidae cont						
Garden Skink	*Lampropholis guichenoti*			×	×	G
Three-toed Skink	*Saiphos equalis*				×	E, G, I
Challenger's Skink	*Saproscincus challengeri*				×	G
Pink-tongued Lizard	*Tiliqua gerrardii*					H
Eastern Blue-tongued Lizard	*Tiliqua scincoides*					G, K
Typhlopidae						
Blackish Blind Snake	*Ramphotyphlops nigrescens*				×	G
Boidae						
Diamond/Carpet Python	*Morelia spilota*				×	E, G, K
Colubridae						
Brown Tree Snake	*Boiga irregularis*					K
Common Tree Snake	*Dendrelaphis punctulatus*			×		E, F, G, K
Freshwater Snake	*Tropidonophis mairii*					H
Elapidae						
Southern Death Adder	*Acanthophis antarcticus*					G
Yellow-faced Whip-snake	*Demansia psammophis*					G, H, I, K
Eastern Small-eyed Snake	*Cryptophis nigrescens*					H, K
Black-bellied Swamp Snake	*Hemiaspis signata*					I
Red-bellied Black Snake	*Pseudechis porphyriacus*					G, K
Eastern Brown Snake	*Pseudonaja textilis*					H, K
Tropidechis						
Rough-scaled Snake	*Tropidechis carinatus*				×	
AMPHIBIANS						
Myobatrachidae						
Tusked Frog	*Adelotus brevis*					F
Pouched Frog	*Assa darlingtoni*		V			C
Eastern Sign-bearing Froglet	*Crinia parinsignifera*			×		H
Common Eastern Froglet	*Crinia signifera*			×	×	E, G, H, I, K
Wallum Froglet	*Crinia tinnula*		V			C, H, I, L
Ornate Burrowing Frog	*Limnodynastes ornatus*			×		F
Brown-striped Frog	*Limnodynastes peronii*			×	×	E, F, G, H, I, K
Spotted Grass Frog	*Limnodynastes tasmaniensis*			×		H
Northern Banjo Frog	*Limnodynastes terraeginae*					G, I
Giant Barred Frog	*Mixophyes iteratus*		V			C
Red-backed Toadlet	*Pseudophryne coriacea*					H
Red-groined Toadlet	*Uperoleia laevigata*					E
	Uperoleia sp			×		
Hylidae						
Green & Golden Bell Frog	*Litoria aurea*	V	E			C
Green Tree Frog	*Litoria caerulea*				×	K
Eastern Dwarf Frog	*Litoria fallax*			×		E, F, H, K
Freycinet's Frog	*Litoria freycineti*			×		E, F, G, H
Dainty Green Tree Frog	*Litoria gracilenta*					E, F, H
Gunther's Frog	*Litoria latopalmata*			×		G, H
Rocket Frog	*Litoria nasuta*			×		G, H
Peron's Tree Frog	*Litoria peronii*			×	×	E
Wallum Tree Frog	*Litoria olongburensis*		V			C, L
Bufonidae						
* Cane Toad	*Bufo marinus*			×	×	E, F, G, H, I, K

APPENDIX 4 contd Fauna species recorded during the field surveys for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun, and during previous investigations in the general vicinity.

Sources of Information

B Birds Australia: bird records for the 10-minute grids centred on 153°35'E 28°25'S and 153°35'E 28°35'S.

C NP&WS Atlas of NSW Wildlife: records from within approximately 10km of the study areas.

D NSW Bird Atlassers records for 10-minute grids centred on 153°35'E 28°25'S and 153°35'E 28°35'S.

E Milledge D & McKinley A. 1992. *A Flora and Fauna Survey for the Route Selection Study, Proposed Pacific Highway Bypass, Brunswick Heads.* Prepared for the Roads & Traffic Authority.

F Kinhill. 1996. *Pacific Highway: Brunswick River to Billinudgel. Route Constraints Study - Preliminary Ecological and Route Investigations.* Prepared for the Roads & Traffic Authority, Grafton.

G MKES. 1994. *Proposed Motorway between Billinudgel and Chinderah. Environmental Impact Statement. Flora and Fauna Assessment, including Requirements for a Fauna Impact Statement.* Prepared for Sinclair Knight Merz, St Leonards. Mount King Ecological Services, Oberon.

H Gilmore & Associates. 1985. *Environmental Study of Wetland South of Pottsville NSW - Wildlife Survey.*

I Milledge D. 1991. A survey of the terrestrial vertebrates of coastal Byron Shire. *Australian Zoologist* **27 (3 & 4)**: 66-90.

J Cathcart S. 1991. *Wildlife Survey of the Vertebrate Fauna of Brunswick Heads Nature Reserve, NSW.* University of New England Northern Rivers. Threatened species records only.

K Report by Mr Rob Oehlman (Northern Rivers Wildlife Carers) on Road Kill Hotspots along the existing Pacific Highway between Brunswick River and Yelgun (1997).

L BSPC. 1996. *Local Environmental Study - Environmentally Sensitive Lands - North Ocean Shores.* Prepared by Balanced Systems Planning Consultants for Byron Shire Council.

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APPENDIX 5

Details of Fauna Records in the Study Area

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APPENDIX 5 Details of fauna species recorded during surveys conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun. Specific details of survey locations are provided in Appendix 2 and indicated on Figure 6.

1 RESULTS of TRAPPING

1.1 Elliott and Cage Trapping

Table 1.1 Results of Elliott and cage trapping surveys conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

Line	Date	Scientific Name	Common Name	Total Captures (#)
1 (B)	19/11/97	*Rattus fuscipes*	Bush Rat	2
		Mus musculus	House Mouse	1
	20/11/97	*Rattus fuscipes*	Bush Rat	1
	21/11/97	*Rattus fuscipes*	Bush Rat	1
	22/11/97	*Rattus fuscipes*	Bush Rat	1
2 (U)	19/11/97	Nil		0
	20/11/97	Nil		0
	21/11/97	Nil		0
	22/11/97	*Isoodon macrourus*	Northern Brown Bandicoot	1
3 (U)	19/11/97	*Rattus fuscipes*	Bush Rat	7
		Rattus fuscipes	Bush Rat	1
	20/11/97	*Rattus fuscipes*	Bush Rat	7
	21/11/97	*Rattus fuscipes*	Bush Rat	2
		Antechinus stuartii	Brown Antechinus	1
	22/11/97	*Rattus fuscipes*	Bush Rat	2
		Antechinus stuartii	Brown Antechinus	1
		Rattus rattus	Black Rat	1
4 (U)	20/11/97	*Rattus fuscipes*	Bush Rat	3
		Antechinus stuartii	Brown Antechinus	1
	21/11/97	*Rattus fuscipes*	Bush Rat	3
	22/11/97	*Rattus fuscipes*	Bush Rat	1
		Antechinus stuartii	Brown Antechinus	1
	23/11/97	*Rattus fuscipes*	Bush Rat	1
5 (U)	19/11/97	*Rattus fuscipes*	Bush Rat	7
		Rattus rattus	Black Rat	1
	20/11/97	*Rattus fuscipes*	Bush Rat	3
	21/11/97	*Rattus fuscipes*	Bush Rat	3
	22/11/97	*Melomys cervinipes*	Fawn-footed Melomys	1
6 (U)	19/11/97	*Rattus fuscipes*	Bush Rat	5
	20/11/97	*Rattus fuscipes*	Bush Rat	4
	21/11/97	*Rattus fuscipes*	Bush Rat	2
	22/11/97	*Rattus fuscipes*	Bush Rat	2
7 (U)	28/11/97	Nil		0
	29/11/97	Nil		0
	30/11/97	*Rattus fuscipes*	Bush Rat	2
	1/12/97	*Melomys cervinipes*	Fawn-footed Melomys	1
	2/12/97	*Melomys cervinipes*	Fawn-footed Melomys	1
8 (U)	28/11/97	*Rattus rattus*	Black Rat	1
	29/11/97	*Rattus rattus*	Black Rat	1
	30/11/97	*Rattus rattus*	Black Rat	1
	1/12/97	Nil		0
	2/12/97	Nil		0
9 (U)	28/11	Nil		
	29/11/97	*Rattus rattus*	Black Rat	2
	30/11/97	*Rattus fuscipes*	Bush Rat	3
	1/12/97	*Rattus fuscipes*	Bush Rat	1
		Tropidechis carinatus	Rough-scale Snake	1
	2/12/97	Nil		0
10 (U)	28/11/97	*Rattus fuscipes*	Bush Rat	3
	29/11/97	*Rattus fuscipes*	Bush Rat	4
	30/11/97	*Rattus fuscipes*	Bush Rat	2
	1/12/97	*Rattus fuscipes*	Bush Rat	2
	2/12/97	Nil		0

B study area for the proposed duplication of the Brunswick Heads Bypass.

U study area for the proposed Pacific Highway upgrade, Brunswick to Yelgun.

includes re-captured individuals

1.2 Pitfall Trapping

Table 1.2 Results of pitfall trapping surveys for the upgrade of the Pacific Highway, Brunswick to Yelgun. Pitfall trapping surveys were only conducted at trapline 2, given various constraints associated with terrain and land tenure at the remaining survey sites (see Appendix 2).

Trap line	Date	Species Recorded	
2 (U)	25/11/97	*Lampropholis guichenoti*	Garden Skink
	27/11/97	*Lampropholis guichenoti*	Garden Skink
	29/11/97	*Saiphos equalis*	Three-toed Skink

U study area for the proposed Pacific Highway upgrade, Brunswick to Yelgun

1.3 Hair Tube Analysis

Table 1.3 Results of hair-tube surveys and analysis conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

Trapline No	Species
1 (B)	• *Rattus* sp*
2 (U)	• *Rattus* sp*
3 (U)	• Bush Rat *Rattus fuscipes* and Swamp Rat *Rattus lutreolus* • Echidna *Tachyglossus aculeatus* • Brown Antechinus *Antechinus stuartii* • Swamp Wallaby *Wallabia bicolor* • Black Rat *Rattus rattus*
4 (U)	• Swamp Wallaby *Wallabia bicolor* • Bush Rat *Rattus fuscipes* ? • Common Ringtail Possum *Pseudocheirus peregrinus* • Mountain Brushtail Possum *Trichosurus caninus* ? • Cat *Felis catus*
5 (U)	• No hairs recorded
6 (U)	• No hairs recorded
7 (U)	• Mountain Brushtail Possum *Trichosurus caninus* ? • Bandicoot species* • Swamp Rat *Rattus lutreolus* ?
8 (U)	• Northern Brown Bandicoot *Isoodon macrourus* • Black Rat *R rattus* or Brown Rat *R norvegicus*
9 (U)	• Broken rodent hair • Bush Rat *Rattus fuscipes*, Swamp Rat *Rattus lutreolus*
10 (U)	• *Rattus* sp* • *Isoodon macrourus* Northern Brown Bandicoot • Swamp Rat *Rattus lutreolus* and Bush Rat *Rattus fuscipes*

* the hair sample broken or too small to identify to species level with confidence.

? tentative identification.

B study area for the proposed duplication of the Brunswick Heads Bypass.

U study area for the proposed Pacific Highway upgrade, Brunswick to Yelgun.

APPENDIX 5 contd Details of fauna species recorded during surveys conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun. Specific details of survey locations are provided in Appendix 2 and indicated on Figure 6.

2 MICROCHIROPTERAN BAT SURVEYS

2.1 Harp Trapping

Table 2.1 Results of the harp trapping surveys conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

Trap	Date	Scientific Name	Common Name	Total Captures
1 (B)	20/11/97	*Syconycteris australis*	★ Queensland Blossom Bat	1
	21/11/97	*Nyctophilus bifax*	★ Eastern Long-eared Bat	1
	22/11/97	Nil	-	0
	23/11/97	Nil	-	0
	24/11/97	Nil	-	0
2 (U)	20/11/97	Nil	-	0
	21/11/97	*Syconycteris australis*	★ Queensland Blossom Bat	1
	22/11/97	*Nyctophilus bifax*	★ Eastern Long-eared Bat	1
	23/11/97	*Nyctophilus bifax*	★ Eastern Long-eared Bat	1
	24/11/97	Nil	-	
3 (U)	29/11/97	*Nyctophilus bifax*	★ Eastern Long-eared Bat	1
	30/11/97	*Nyctophilus bifax*	★ Eastern Long-eared Bat	2
	31/11/97	Nil	-	0
	1/12/97	*Nyctophilus bifax*	★ Eastern Long-eared Bat	1
		Scoteanax orion	Eastern Broad-nosed Bat	1
	2/12/97	Nil	-	0
	3/12/97	Nil	-	0
4 (U)	29/11/97	Nil	-	0
	30/11/97	Nil	-	0
	31/11/97	Nil	-	0
	1/12/97	Nil	-	0
	2/12/97	Nil	-	0
	3/12/97	Nil	-	0

★ Vulnerable species (Schedule 2 of the TSC Act 1995).

B study area for the proposed duplication of the Brunswick Heads Bypass.

U study area for the proposed Pacific Highway upgrade, Brunswick to Yelgun.

2.2 Anabat II Recordings

Table 2.2 Microchiropteran bat species identified from calls recorded using Anabat II ultrasonic call detectors.

Date	Common Name	Scientific Name	Reliability
19/11/97 (B)	★ Greater Broad-nosed Bat	*Scoteanax rueppellii*	Po
19/11/97 (B)	Eastern Broad-nosed Bat	*Scotorepens orion*	P
27/11/97 (U)	★ Little Bent-wing Bat	*Miniopterus australis*	P
27/11/97 (U)	Eastern Forest Bat	*Vespadelus pumilus*	P
1/12/97 (U)	Eastern Forest Bat	*Vespadelus pumilus*	P

★ Vulnerable species (Schedule 2 of the TSC Act 1995).

D Definite identification **P** Probable **Po** Possible identification

B study area for the proposed duplication of the Brunswick Heads Bypass.

U study area for the proposed Pacific Highway upgrade, Brunswick to Yelgun.

APPENDIX 5 contd Details of fauna species recorded during surveys conducted for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun. Specific details of survey locations are provided in Appendix 2 and indicated on Figure 6.

3 SPOTLIGHT SURVEYS

Table 3.1 The results of spotlighting surveys conducted for the proposed duplication of the Brunswick Heads Bypass and the upgrade of the Pacific Highway, Brunswick to Yelgun. The approximate locations of threatened species recorded are indicated on Figure 10.

Date	Location	Common Name	Scientific Name	Number
Proposed duplication of the Brunswick Heads Bypass				
19/11/97	Bypass alignment	Red-necked Wallaby	*Macropus rufogriseus*	2
		★ Squirrel Glider	*Petaurus norfolcensis*	1
		Grey-headed Flying Fox	*Pteropus poliocephalus*	1
21/11/97	Bypass alignment	Swamp Wallaby	*Wallabia bicolor*	1
		Northern Brown Bandicoot	*Isoodon macrourus*	1
		Common Ringtail Possum	*Pseudocheirus peregrinus*	1
		Grey-headed Flying Fox	*Pteropus poliocephalus*	1
Proposed upgrade of the Pacific Highway, Brunswick to Yelgun				
18/11/97	Billinudgel NR	* Cane Toad	*Bufo marinus*	numerous
	Tunnel Road	* Cane Toad	*Bufo marinus*	numerous
		Tawny Frogmouth	*Podargus strigoides*	1
20/11/97	STP and properties to the east	Common Ringtail Possum	*Pseudocheirus peregrinus*	2 (adult & young)
		Mountain Brushtail Possum	*Trichosurus caninus*	1
	Brunswick Heads NR	No sightings		
22/11/97	Brunswick Heads NR & Sewage Treatment Plant Road	Grey-headed Flying Fox	*Pteropus poliocephalus*	numerous
27/11/97	Banana Road	★ Koala (~ 4-5 years old)	*Phascolarctos cinereus*	1
		* Cane Toad	*Bufo marinus*	numerous
28/11/97	Billinudgel NR	* Cane Toad	*Bufo marinus*	numerous
		# Land Mullet	*Egernia major*	1
		# Eastern Water Dragon	*Physignathus lesueurii*	1
01/12/97	Billinudgel NR	No sightings		
	Banana Road	★ Koala (~ 3-4 years old)	*Phascolarctos cinereus*	1
		Feathertail Glider	*Acrobates pygmaeus*	1
		Green Tree Frog	*Litoria caerulea*	calls
		* Cane Toad	*Bufo marinus*	numerous
	Mudges Quarry Road	Common Ringtail Possum	*Pseudocheirus peregrinus*	2
		Peron's Tree Frog	*Litoria peronii*	calls
		* Cane Toad	*Bufo marinus*	numerous

\# fresh kill/half eaten.

★ Vulnerable species (Schedule 2 of the TSC Act 1995).

4 KOALA SCAT SURVEYS

- Koala scat searches were restricted to the study area for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun;
- the study area for the proposed Brunswick Heads Bypass was not surveyed because it was inundated with water at the time of the survey as a result of recent heavy rain;
- Koala scat searches within the proposed upgrade study area may have been biased by heavy rain prior to the survey commencing; pellets may have deteriorated beyond recognition or washed away;
- opportunistic surveys for Koala scats conducted throughout the study area during all surveys.

Table 4.1 Results of dedicated Koala scat searches conducted for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

Location	Trees Searched	Species Name	No. Searched	Koala Scats
Brunswick NR (eastern side)	Pink Bloodwood	*Eucalyptus intermedia*	19	Nil
	Tallow-wood	*Eucalyptus microcorys*	20	Yes
	Forest Red Gum	*Eucalyptus tereticornis*	4	Nil
	Brush Box	*Lophostemon confertus*	7	Nil
Tunnel Rd	Flooded Gum	*Eucalyptus grandis*	20	Nil
Billinudgel NR	Tallow-wood	*Eucalyptus microcorys*	20	Yes
	Brush Box	*Lophostemon confertus*	6	Nil
	Pink Bloodwood	*Eucalyptus intermedia*	25	Nil

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APPENDIX 6
Threatened Flora Species Profiles

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APPENDIX 6 Species profiles for threatened flora considered of potential relevance to the proposed upgrade of the Pacific Highway, Brunswick to Yelgun.

STINKING CRYPTOCARYA *Cryptocarya foetida*

Family
Lauraceae

Species Description
A small to medium rainforest tree with alternate leaves, obovate to elliptical between 5-12cm long and cream flowers 2mm long with an offensive odour (Harden 1990). Flowering has been recorded from December to February and in May (Quinn *et al* 1995). The fruit is globose, purplish to black and 10mm in diameter.

Habitat and Associations
Occurs in littoral rainforest on old sand dunes, and in subtropical rainforest over slate and occasionally basalt derived soils, at altitudes below 150m (WBM Oceanics 1996). Associated species include *Acmena hemilampra, Acronychia imperforata, Cryptocarya triplinervis, Cupaniopsis anacardioides, Flindersia bennettiana, Lophostemon confertus* and *Syzygium luehmannii* (Quinn *et al* 1995).

Status

Australia — Part 2 - Vulnerable (*ESP Act* - update January 1998). ROTAP Risk Code 3VCi (Briggs & Leigh 1996).

NSW — Schedule 2 - Vulnerable (*Threatened Species Conservation Act* 1995).

Regional — As for the State.

Local — As for the State.

Distribution

Australia — Recorded from near Iluka on the north coast of NSW and north to Fraser Island in Qld (WBM Oceanics 1996). Quinn *et al* (1995) list a total of 39 locations for the species in NSW and 7 in Queensland. *C foetida* occurs in most littoral rainforest remnants from the Ballina area north to the Queensland border, and the species extends inland to a few areas such as Mooball SF and Inner Pocket NR, where it tends to be very rare (Benwell 1997d).

NSW — Recorded in the Tweed Heads Remnant Bushland Inventory (*in prep*). *C foetida* has also been recorded at Ballina Fingal Head; Cabarita near Kingscliff; Brunswick Head NR; south of Lennox Head; Ocean Shores, north of Brunswick Heads; Point Danger; Byron Bay; Chickiba Creek, Ballina; Ukerabagh, Tyagarah, Inner Pocket and Broken Head Nature Reserves; Meerschaum Vale; Buckombil; Mooball SF; Suffolk Park; Farrants Hill, Iluka NR - southern limit (Sheringham & Westaway 1995).

Regional — As for the State.

Local — This species was recorded at three locations in the study area (Figure 9):

- west of the existing Highway within Brunswick Heads NR;
- east of the existing Highway within Brunswick Heads NR; and
- south-facing slopes between Brunswick Heads NR and the sewage treatment plant (Benwell 1997d).

Abundance

Australia — Young plants are relatively common in littoral rainforest and sub-littoral open-forest north from the Richmond River. However, mature specimens are relatively rare in these areas, being more common at Brunswick Heads, Fingal and on the north side of Terranora Broadwater (J Hunter 1995, *pers comm*).

NSW — Approximately 100 individuals of *C foetida* have been recorded from the coastal side of Brunswick Heads NR; 650 plants recorded from Behind Lagoon Road,

Fingal Head on private property; and approximately 100 plants recorded from Cosy Corner, Cape Byron Headland Reserve (Quinn *et al* 1995).

Regional — As for the State.

Local — A total of 13 individuals were recorded on Route A2 east of the existing highway within Brunswick Heads NR, and south-facing slopes between Brunswick Heads NR and the sewage treatment plant. All plants were juveniles, less than 1.5 metres high (Benwell 1997d).

Threatening Processes
Much of the original habitat of this species has been destroyed through clearing for urban development and sand-mining, and high fire frequency of habitats is an additional threatening process (Leigh *et al* 1984). Sand-mining has depleted populations in the past, particularly in the Kingscliff-Cudgen area. The individual observed at Cabarita in 1964 was recorded in an area of remnant rainforest being cleared for rutile mining (Quinn *et al* 1995). Clearing for residential development in the sublittoral zone (habitat for this species) remains a key threat. Proposed widening of the Wooyung to Kingcliff coastal road is also likely to reduce habitat for this species (Gross *pers comm*).

Weed invasion of smaller habitat remnants is a potential long-term threat to some populations. Little information is available regarding the susceptibility and response to disturbance of this species, but it appears that the species does not recruit naturally in areas that have been subjected to intensive sand-mining in the Kingscliff-Cudgen area (Quinn *et al* 1995).

Regional Reserves
Brunswick Heads, Broken Head, Inner Pocket, Ukerabagh, Tyagarah and Iluka NRs. Mooball SF.

General Notes
An extensive list of populations, and management requirements, are detailed in Quinn *et al* (1995).

DAVIDSON'S PLUM — *Davidsonia pruriens* subsp *jerseyana*

Family
Davidsoniaceae

Species Description
A slender tree to 10m with alternate, oblong to oblanceolate leaves between 35 and 60cm long. The young shoots and fruits are covered with dense, fine irritant hairs and the inflorescence is a pendulous panicle produced from October through to January, followed by a blue-black drupe (Quinn *et al* 1995).

Habitat and Associations
Occurs in Subtropical Rainforest on red or yellow podzolic soils on metasedimentary geology. Generally occurs at altitudes less than 300m over Silurian greywacke, slate, phylittic, or quartzite (WBM Oceanics 1996).

Status
Australia — Part 1 - Endangered (*ESP Act* - update January 1998). ROTAP Risk Code 2ECi (Briggs & Leigh 1996).

NSW — Schedule 1 - Endangered (*Threatened Species Conservation Act* 1995).

Regional — As for the State.

Local — As for the State.

Distribution
Australia — Confined to the Tweed and Brunswick Rivers of NSW (WBM Oceanics 1996; Quinn *et al* 1995).

NSW — Endemic to the north coast of NSW in the lower Brunswick and Tweed valleys (Floyd 1989; Quinn *et al* 1995). *D puriens* subsp *jerseyana* has been recorded at Brunswick Bridge; Inner Pocket NR; Billinudgel Rd; northeast of Mullumbimby on Coolamon Scenic Drive; Durrumbul, west of Mullumbimby; east of Mooball; Chillingham, Tweed River; north of Pottsville; Hogans Scrub, Tumbulgum;

Chilcotts Rd; Old Lismore Road; Brunswick Heads NR, which is the southern limit of this species; North Ocean Shores (Sheringham & Westaway 1995); and other locations on private property listed in Quinn *et al* (1995).

Regional — In the lower Brunswick Valley, *D pruriens* subsp *jerseyana* occurs in Brush Box *Lophostemon confertus* forest and rainforest from near the mouth of the Brunswick River upstream to Durrumbil, a distance of about 10km.

Local — This species was recorded in regrowth Brush Box *Lophostemon confertus* forest and rainforest at three locations within the study area (Figure 9):

- south facing slopes between the Brunswick River Bridge and Banana Rd;
- west of the Salad Bowl Caravan Park; and
- regrowth forest alongside the railway line at the northern end of the study area. Individuals recorded were mainly mature specimens (6-9m).

Abundance

Australia — Many populations are considered small, and a number of isolated specimens have been found on cleared land devoid of seedling growth.

NSW — As for the region.

Regional — Approximately 70 individuals of Davidson's Plum occur in the vicinity of the Brunswick River and Midjimbil Creek, to the west of the existing western boundary of Brunswick Heads NR (WBM Oceanics 1996; Quinn *et al* 1995). A number of individuals of Davidson's Plum have been recorded on private property, as listed in Quinn *et al* (1995).

Local — Approximately 45 individuals of *D pruriens* subsp *jerseyana* were recorded on or very close to Route A2 on south-facing slopes between the Brunswick River Bridge and Banana Rd. At least another 20 plants were recorded on south-facing slopes between the Brunswick River Bridge and Banana Rd, outside the A2 corridor, further downslope towards the edge of swamp sclerophyll forest. Earlier surveys for the route selection study identified a population of 100-200 individuals further upstream where the River bends to the west, outside the study area (Benwell 1997c). West of the Salad Bowl Caravan Park, a population of 30-50 plants occurs west of the railway line, well outside Route A2. A single adult plant was recorded west of the Salad Bowl Caravan Park, about 100m west of Route A2. Generally this species is rare in the lower Brunswick valley area, with a total population estimated at 1000-1500 plants.

Threatening Processes

Extensive clearing of lowland subtropical rainforest for agriculture and grazing has probably had an impact on most populations (Quinn *et al* 1995). Further clearing poses a threat to some populations that are located on private property (Quinn *et al* 1995). Many listed populations occur on minor roadside verges and are potentially threatened by roadworks. Many populations are too small to be viable in the long term.

Regional Reserves

Brunswick Heads, Inner Pocket and Billinudgel NRs.

General Notes

- Other common names include Ooray;
- it has been suggested that this taxon is distinct at species level from *Davidsonia pruriens* var *pruriens* of North Queensland (Elliot & Jones 1984);
- this taxon is considered a high priority for a Recovery Plan (Quinn *et al* 1995);
- *Davidsonia pruriens* subsp *jerseyana* is currently being cultivated at Coffs Harbour and Mt Annan Botanic Gardens. It is a wild food plant, cultivated widely by private landholders;
- the number of roadside occurrences of this species indicate that it may benefit from some level of disturbance or that it was purposely left because it is an edible plant;
- management requirements are listed in Quinn *et al* (1995);
- fresh seeds germinate readily (Floyd 1989).

HAIRY QUANDONG ***Elaeocarpus williamsianus***

Family
Elaeocarpaceae

Species Description
Elaeocarpus williamsianus is a small rainforest tree to 15m in height and 18cm in diameter, that is occasionally multi-stemmed from ground level. The bark is finely pustulate and fawn or cream in colour. The branchlets and shoots have dense rusty hairs and the leaves are spirally alternate, oblanceolate, with eight to two pairs of inconspicuous irregular broad teeth. Flowers are borne on racemes in the leaf axils, with 11-16 pendulous, pale green flowers per raceme, and the fruit is a drupe, Prussian Blue in colour. This species flowers from November to December (NP&WS 1996).

Habitat and Associations
E williamsianus is a very rare rainforest tree, and favours medium fertility soils formed on metasediment. It is known to occur in Brush Box forest and rainforest. The known habitat of this species is the lower slopes of deeply dissected coastal foothills, on acid quartzols yellow-brown clay loam soils of metasedimentary origin. These soils may be enriched with basaltic colluvium (Benwell 1997d; WBM Oceanics 1996).

Status

Australia	Part 1 - Endangered (ESP 1992 - update January 1998). ROTAP Risk Code 2ECi (Briggs & Leigh 1996).
NSW	Schedule 1 - Endangered (*Threatened Species Conservation Act* 1995).
Regional	As for the State.
Local	As for the State.

Distribution

Australia	As for the State.
NSW	Burringbar Range, North Coast; west of Burringbar Range; within but close to boundary of Inner Pocket NR (NP&WS 1996; WBM Oceanics 1996; Sheringham & Westaway 1995).
Regional	Known from 6 locations in the region - Couchy Creek in the Tweed Valley, Mooball SF, Upper Burringbar, Inner Pocket NR, Goonengerry and Banana Road (Benwell 1997d). The population at Inner Pocket NR occurs at an altitude of 140m near the junction of Lacks Creek and an unnamed watercourse that drops steeply to the south (NPWS 1996).
Local	The distance between Route A2 (including batters) and the population of *E williamsianus* is estimated to be approximately 100 metres. In addition to the above populations, a single tree was located about 100 metres to the east and further upslope, approximately 50 metres from the Route A2 batter (Figure 9).

Abundance

Australia	The total known population is probably less than 300 trees (J Hunter *pers comm*).
NSW	As for Australia.
Regional	As for the State.
Local	As for the State.

Threatening Processes
Low numbers and a narrow genetic base are medium to long-term threats to this species (Briggs & Leigh 1992). The major threats are fire, weed invasion (particularly *Lantana camara*) and possible erosion. Undiscovered populations may exist (NP&WS 1996). The main limitation to expanding the population of this species is lack of suitable habitat with secure tenure (NP&WS 1996).

Regional Reserves
One population is reserved in Inner Pocket NR. (WBM Oceanics 1996; Briggs & Leigh 1996; 1992).

General Notes

- A major limitation in species' recovery work has been the apparent infertility of seed and failure of plants to propagate vegetatively, although natural vegetative reproduction appears to occur in the wild state (Benwell 1997d);

- germination is difficult and erratic (Floyd 1989).

CRYSTAL CREEK WALNUT ***Endiandra floydii***

Family
Lauraceae

Species Description
A small rainforest tree endemic to the Tweed and Brunswick Valleys. Leaves are elliptic to narrow-elliptic, 5-15cm long and 2-5cm wide. Flowers are 3mm long, green to cream and glabrous and the fruit is ovoid to oblong and red to purplish black when ripe (Harden 1990).

Habitat and Associations
Subtropical rainforest on soils derived from metasediment often on steep slopes from sea level to 430m (WBM Oceanics 1996). It occurs in Brush Box forest and rainforest in the lower Brunswick Valley from the mouth of the Brunswick River inland to Mt Chincogan near Mullumbimby (Benwell 1997d).

Status

Australia	Part 1 - Endangered (ESP 1992 - update January 1998). ROTAP Risk Code 2VC- (Briggs & Leigh 1996).
NSW	Schedule 1 - Endangered (*Threatened Species Conservation Act* 1995).
Regional	As for the State.
Local	As for the State.

Distribution

Australia	Confined to the Tweed district on the north coast of NSW (WBM Oceanics 1996).
NSW	Recorded near Tomewin, NNW of Murwillumbah, Border Gates; Ocean Shores; Upper Crystal Creek; southern limit of Brunswick Heads NR (Sheringham & Westaway 1995). Occurs in the Burringbar Range, including Mooball SF and the foothills of the McPherson Range in the Tweed Valley (Benwell 1997d).
Regional	As for the State.
Local	*E floydii* was recorded in Brush Box forest and rainforest at four locations within the study area (Figure 9): • properties in Oola place backing onto the existing highway; • regrowth forest immediately west of Brunswick Heads NR; • steep slopes below Banana Rd; and • rainforest west of the Salad Bowl Caravan Park (Benwell 1997d).

Abundance

Australia	As for the region.
NSW	As for the region.
Regional	The total population in the Brunswick Valley is estimated at between 300 and 500 mature trees (Benwell 1997d).
Local	The largest populations detected during the flora surveys for the highway were in Brunswick Heads NR and the Hilans Corner area. A total of five mature trees and two juveniles were recorded on or very close to Route A2 and its batters, at properties in Oola place backing onto the existing Highway and steep slopes below

Banana Rd. Plants located in regrowth forest immediately west of the Brunswick Heads NR were approximately 100 metres from Route A2, and plants located in rainforest west of the Salad Bowl Caravan Park were well outside Route A2.

Threatening Processes

- Not determined.

Regional Reserves
Brunswick Heads and Numbinah NRs.

GREEN-LEAVED ROSE WALNUT ***Endiandra muelleri* subsp *bracteata***

Family
Lauraceae

Species Description
A tree to 30m, shortly buttressed with brown bark and leaves broad-lanceolate to elliptic, usually 6-12cm long. Flowers are 2mm long, yellowish and hairy. Fruit is ovoid, black and ripens in April (Harden 1990).

Habitat and Associations
Inhabits lowland Brush Box forest or subtropical rainforest on medium fertility soils or metasediment at lower altitudes (Benwell 1997d; WBM Oceanics 1996).

Status

Australia	ROTAP Risk Code 2VCi (Briggs & Leigh 1996).
NSW	Schedule 1 - Endangered (*Threatened Species Conservation Act* 1995).
Regional	As for the State.
Local	As for the State.

Distribution

Australia	The distribution of *E muelleri* subsp *bracteata* is poorly known, partly because of confusion with its identification. The species is found north from Maclean in NSW, but occurs mainly on the eastern margin on the Mt Warning shield (Benwell 1997d; WBM Oceanics 1996).
NSW	Eastern margin of the Mt Warning shield (Benwell 1997d).
Regional	Recently recorded from Mooball SF and probably reserved in Brunswick Heads NR (Benwell 1997d) and Maclean Reserve (WBM Oceanics 1996).
Local	Recorded in Brush Box forest and rainforest at four locations within the study area (Figure 9): • properties in Oola Place backing onto the existing Highway; • south facing slopes between the Brunswick River and the sewage treatment works; • slopes below Banana Rd; and • Old Stock Route near Billinudgel.

Abundance

Australia	As for the State
NSW	There is insufficient information for an exact estimate of abundance. However, abundance is expected to be very low.
Regional	This species is expected to have a low abundance in the region, due to the limited number of records.
Local	A total of 13 mature trees and several juveniles were recorded at properties in Oola

Place backing onto the existing Highway; south facing slopes between the Brunswick River and the sewage treatment plant; slopes below Banana Rd and the Old Stock Route near Billinudgel on or very close to Route A2 and its batters.

Threatening Processes
Not determined.

Regional Reserves
Brunswick Heads NR, Mooball SF, Maclean Reserve.

QUEENSLAND NUT ***Macadamia tetraphylla***

Family
Proteaceae

Species Description
A small to medium-sized tree to 15m in height and often multi-trunked close to the base. The adult leaves are in whorls of 4 (occasionally 3-5), oblong to lanceolate 2-5cm wide and 18-25cm long. The inflorescence is borne between August and October and is followed by a globose nut. The fruit is ripe in January (Harden 1991).

Habitat and Associations
Occurs in lowland subtropical rainforest on metasediment, basalt and alluvium (Floyd 1989).

Status

Australia	Schedule 1, Part 2 - Vulnerable (*ESP Act* 1992 - update January 1998). ROTAP Risk Code 2VC- (Briggs & Leigh 1996).
NSW	Schedule 2 - Vulnerable (*Threatened Species Conservation Act* 1995).
Regional	As for the State.
Local	As for the State.

Distribution

Australia	*M tetraphylla* is endemic to the eastern margin of the Mt Warning shield, between Rous near Lismore and Mt Tamborine in Queensland. Intergrades between this species and *M integrifolia* have been found near Beechmont, the Tambourine Mountain area and north to Wangawallen Creek, where both species co-exist (Quinn *et al* 1995).
NSW	As for Australia.
Regional	Recorded at Upper Dungay Creek, north of Murwillumbah; Bilambil; Crystal Creek, NW of Murwillumbah; Davis Scrub NR, 10km S of Lismore; Rocky Creek, Whian Whian SF; east of Mooball; Alstonville; Ballina; Moore Park NR (on the upper Richmond River); Mullumbimby; Border Gate near Natural Ridge Tweed River; Chillingham; Goonengerry, south of Mullumbimby; Banora Point; Coolardie Rd, Wardell; Couchy Creek; Hogans Scrub; Kellin Falls, Emigrant Creek; Maclean RR; Minyon FR; Numinbah NR; Victoria Park NR (Alstonville); Southern Limit - Wollongbar Ag Res Stn; Cedar Creek; East of Cedar Creek, south of Mt Warning; Ridgeline to the west of Portion 68 (part of Mt Warning NP); NW of Tyalgum; Big Scrub FR; Lennox Head SEPP 26, Limpinwood Rd; east of Nimbin; Inner Pocket NR, Burringbar; Glendower; Willowbank; Lumley Park; Meerschaum Vale; Hayter's Hill, Mt Nullum area; Crystal Creek; Red Scrub FR; Big Scrub FR; Minyon Falls FR; Mt Warning NP; Victoria Park NR; Numinbah NR (Quinn *et al* 1995; Sheringham & Westaway 1995).
Local	A single individual was recorded on the western side of the sewage treatment plant access road, in regrowth rainforest (Figure 9). This adult tree was estimated to be approximately 120m from Route A2 and therefore will not be affected (Benwell 1997d).

Abundance

Australia — Many populations are small. In Queensland, 17 locations have been recorded for this species (Quinn *et al* 1995).

NSW — Quinn *et al* (1995) lists a total of 46 locations for this species in NSW. However, populations at any given location tend to be very small, less than 10 to 20 individuals (P Pisanu UNE *pers comm*).

Regional — As for the State.

Local — As for the State.

Threatening Processes

Much of the lowland rainforest within the historical geographical range of this species has been cleared for agricultural and urban development. It is almost certain that this has caused a reduction in population numbers of this species (Quinn *et al* 1995). Weeds and trampling threaten the populations of *Macadamia tetraphylla* at Lennox Head (Quinn *et al* 1995).

Low numbers are a threat to the long-term viability of many of the extant populations of this species. Many reserved populations are quite small and occur in very small isolated reserves. Habitat degradation, due to edge-effects and weed-invasion, could present a threat to these populations. Populations in NPs are probably relatively secure (Quinn *et al* 1995).

Regional Reserves

Nightcap and Mt Warning NPs. Numbinah, Davis Scrub Victoria Park and Limpinwood NRs.

General Notes

- This species is considered to be of high priority for a Recovery Plan (Quinn *et al* 1995);
- it is currently being cultivated at several locations, as documented in Quinn *et al* (1995);
- a number of the populations listed by Quinn *et al* (1995) may have been planted from cultivated material;
- management requirements are listed in Quinn *et al* (1995);
- although little information is available regarding the susceptibility and response to disturbance of this species. It is likely to be fire sensitive (Quinn *et al* 1995).

SPINY GARDENIA ***Randia moorei***

Family

Rubiaceae

Species Description

A shrub or small tree (reaching 10m in height) with opposite, ovate to obovate leaves 1-5 mm long and strongly scented cream to yellow flowers in spring. The plant often bears spines in the leaf axils and produces a orange/yellow fruit (Quinn *et al* 1995).

Habitat and Associations

Occurs in subtropical, riverine and littoral rainforest on a range of substrates, including deep alluvial, basalt and slate derived soils at altitudes to 500m (WBM Oceanics 1996).

Status

Australia — Part 1 - Endangered (ESP Act 1992 - update January 1998). ROTAP Risk Code 3ECi (Briggs & Leigh 1996).

NSW — Schedule 1 - Endangered (*Threatened Species Conservation Act* 1995).

Regional — As for the State.

Local — As for the State.

Distribution

Australia — Known from the Lismore area and north to the Logan River in southern Queensland (Quinn *et al* 1995). A total of 23 locations are listed for the species in NSW and eight in Queensland (Quinn *et al* 1995).

NSW — *R moorei* is restricted to the lower Brunswick and Tweed Valleys in NSW. It has been recorded at Mullumbimby; Brunswick River, northwest of Brunswick Heads, Bilambil; Brunswick Heads; north Tumbulgum; Banora Point, Tweed River, Terranora; Upstream from Banora Point Bridge; Brunswick Heads northern end Pacific Hwy; Brunswick Heads NR; Hogans Scrub; Stotts Island NR; Brays Park, Murwillumbah; Tyalgum Road; Wilsons Park, Lismore; Broken Head NR-southern limit; Upper Burringbar; Mooball SF; Broken Head NR, and Stotts Island NR (Quinn *et al* 1995).

Regional — As for the State.

Local — This species was recorded at two locations within the study area

- west of the existing Highway within Brunswick Heads NR; and
- east of the existing Highway within Brunswick Heads NR (Benwell 1997d).

Abundance

Australia — As for the State

NSW — There is not enough information for an exact estimate of abundance, but abundance is expected to be very low.

Regional — Between 10-40 individuals have been recorded within Brunswick Heads NR, at the northern end of the bridge on the existing Pacific Highway (Quinn *et al* 1995).

Local — Two individuals were recorded on Route A2) in the rainforest margin. Several individuals were recorded on the opposite side of the highway outside the Route A2 corridor (Figure 9). During surveys for the route selection study, a few individuals of this species were recorded in the Hilans Corner area (Benwell 1997b).

Threatening Processes

Much of the original habitat of *Randia moorei* has been cleared (Quinn *et al* 1995).

Activities such as road widening, quarrying, cattle grazing and weed invasion are threats to the Queensland population (Barry & Thomas 1994). Some of the reserved NSW populations, such as those in Wilsons Park, are at threat due to the small population sizes and degradation of remaining habitat by weeds. No information is available regarding the susceptibility and response to disturbance of this species (Quinn *et al* 1995).

Regional reserves

Brunswick Heads, Broken Head and Stotts Island NRs.

General Notes

- Previously known as *Xeromphis* sp (Floyd 1989; Williams & Harden 1979);
- the genetic placement of this species is in doubt (Quinn *et al* 1995);
- populations occurring on private property and in State Forests are listed in Quinn *et al* (1995);
- management requirements are listed in Barry & Thomas (1994);
- the species is currently being cultivated at Coffs Harbour Botanic Gardens and at Mullumbimby (Australian Network for Plant Conservation 1993). It strikes well from cuttings and the seed germinates after approximately 3 months.

RED LILLY PILLY ***Syzygium hodgkinsoniae***

Family
Myrtaceae

Species Description
A small rainforest tree with smooth fibrous to flaky bark. Leaves are broad-elliptic to ovate or obovate, 7-13cm long. The inflorescence are terminal or in upper axils. Flowering time is February to March. The fruit is globose with a solitary red seed (Harden 1991).

Habitat and Associations
It occurs on basaltic soil, alluvium and metasediment derived soils in Brush Box forest, riverine gallery rainforest and subtropical rainforest up to an altitude of about 500m (Benwell 1997d; WBM Oceanics 1996).

Status

Australia	Part 2 - Vulnerable (ESP Act 1992 - update January 1998). ROTAP Risk Code 3VC- (Briggs & Leigh 1996).
NSW	Schedule 2 - Vulnerable (*Threatened Species Conservation Act* 1995).
Regional	As for the State.
Local	As for the State.

Distribution

Australia	Distributed from the Richmond River to Kin Kin in southeast Queensland.
NSW	Restricted to the far northeast corner where it widespread but uncommon. Its range includes Broken Head, Lennox Head and Brunswick Heads near the coast, the Big Scrub area around Lismore and Alstonville, Nullum and Mooball SF, Mt Warning and much of the Tweed Valley (Benwell 1997d). This species is reserved in National Parks and Nature Reserves in the Richmond, Brunswick and Tweed districts. It has been recorded at Billinudgel; Brunswick Heads; Crabbes Creek; Gorge below Minyon Falls; Hayters Hill NR; Couchy Creek; Bilambil; east of Mooball; Repentance Creek; Whian Whian SF; Rous; Richmond River; Mullumbimby Creek, west of Mullumbimby; Broken Head NR; Dungay Creek; Big Scrub FR; Boatharbour NR; Brunswick Heads NR; Crystal & Couchy Creeks; Davis Scrub NR; Emerys Scrub; Hogans Scrub; Johnstons Scrub; Kellin Falls; Emigrant Creek; Oxley River, Limpinwood NR; Minyon Falls FR; Mooball SF; Nobles Scrub; Numinbah NR; Mt Cougal; Wanganui-Upper Coopers Creek; Snows Gully NR; Wollumbin Creek, Mt Warning NP; Marshalls Falls, Alstonville; Cudgera Rd; Rosebank; Tintenbar; Tyalgum; Wanganui; Inner Pocker NR; Rocky Creek; Dawes Bush; Maguires Creek; Duck Creek; Lumley Park; Brockley; Mollys Grass; Victoria Park (southern limit); Rotary Park; Mt Nullum; Grays Lane, Tyagarah; Big Scrub FR; Boatharbour NR; Davis Scrub NR; Hogans Scrub; and Emerys Scrub (Sheringham & Westaway 1995; NP&WS 1994).
Regional	As for the State.
Local	This species was recorded at three locations within the study area: • west of the existing highway within Brunswick Heads NR; • east of the existing highway within Brunswick Heads NR; and • Old Stock Route Rd (Benwell 1997d).

Abundance

Australia	As for the Region.
NSW	As for the Region.
Regional	Comprehensive population data are not available for the species, but at least 1000 plants are estimated to occur in Nullum and Mooball SF (*unpublished data* Comprehensive Regional Assessment).
Local	Two individuals (one mature and one juvenile) were recorded on Route A2, and other plants were outside the corridor (Figure 9).

Threatening Processes
None stated.

Regional Reserves
Brunswick Heads, Inner Pocket, Boatharbour, Davis Scrub, Numinbah, Hayters Hill, Limpinwood, Snows Gully and Johnstons Scrub NRs. Nightcap and Mt Warning NPs. Minyon Falls and Big Scrub FRs.

COOLAMON TREE ***Syzygium moorei***

Family
Myrtaceae

Species Description
A medium-sized to large tree, with flaky bark, a dense crown and pink inflorescence. Leaves are oblong to elliptic and the fruit is depressed-globose 20-30mm long. Flowering time extends between November and March (Harden 1991).

Habitat and Associations
Lowland subtropical rainforest, on basaltic alluvium (WBM Oceanics 1996).

Status

Australia	Part 2 - Vulnerable (ESP Act 1992 - update January 1998). ROTAP Risk Code 2VCi (Briggs & Leigh 1996).
NSW	Schedule 2 - Vulnerable (*Threatened Species Conservation Act* 1995).
Regional	As for the State.
Local	As for the State.

Distribution

Australia	Restricted to the Richmond, Brunswick and Tweed River systems on the north coast of NSW (WBM Oceanics 1996).
NSW	Endemic to the eastern margin of the Mt Warning shield. This species is restricted to the northeastern coast of NSW (Benwell 1997d).
Regional	Recorded at Binna Burra, NSW; Crabbes Creek; Mullumbimby; Stokers Siding; Tintenbar; Dungay Creek; Byron Bay; Numinbah NR; Banora Point; Brays Scrub; Brunswick Heads NR - southern limit; Hayters Hill NR; Couchy Creek; Everest, Eungella; Hogans Scrub; Kellin Falls, Emigrant Creek; Mooball SF; Round Mountain; Couchy Creek Rd, Numinbah; Cudgen Creek (north of the alignment); Cudgera Creek Rd (north of the alignment); Federal; Fungal Head; Kyogle Rd, Murwillumbah; Limpinwood Rd; Boatharbour; Ocean Shores Estate; Billinudgel; Round Mountain; Sheens Creek; Uki Rd, Murwillumbah; Mudgen Flat; South Ocean Shores; and Upper Main Arm (Sheringham & Westaway 1995).
Local	Recorded at three locations within the study area (Figure 9): • west of existing Highway within Brunswick Heads Nature Reserve; • east of the existing Highway within Brunswick Heads NR; and • rainforest west of the Salad Bowl Caravan Park. All plants recorded) were outside the Route A2 corridor (Benwell 1997d).

Abundance

Australia	As for the State.
NSW	There is not enough information to provide an exact estimate of abundance, but abundance is expected to be very low.
Regional	As for the State.
Local	As for the State.

Threatening Processes
Habitat clearing, fragmentation and degradation of riverine rainforests.

Regional Reserves
Brunswick Heads, Numbinah, Hayters Hill and Stotts Island NRs.

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 7

Threatened Fauna Species Profiles

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APPENDIX 7 Species profiles for threatened fauna considered of particular relevance to the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun.

OSPREY ***Pandion haliaetus***

Habitat Requirements

In Australia, the Osprey inhabits coastal lands, offshore islands, littoral habitats, terrestrial wetlands and the margins of estuaries, rivers and lakes (Marchant & Higgins 1993). Birds forage for fish over clear open and usually sheltered waters (fresh, brackish or saline). Breeding is usually confined to the coast and offshore islands (Blakers *et al* 1984), and Ospreys generally nest near areas of open water for fishing, and in a prominent open position for access and visibility (Marchant & Higgins 1993). The nest is usually placed high in a tree or on a rock ledge or cliff, although these birds will readily use artificial nest sites in developed areas (Debus 1994). Breeding pairs can display high nest-site fidelity, and may return to the same nest-site over successive years (Marchant & Higgins 199s).

Distribution

Australia — The species is predominantly coastal, although known to range inland along large rivers, particularly in the north. It appears to have a disjunct distribution, occurring continuously from Broome in WA, across northern Australia to the south coast of NSW, from Esperance to Cape Keraudren in the west, and from Kangaroo Island to the Great Australian Bight in the south (Marchant & Higgins 1993). Estimated total distributional range of 300000 to 1 million km^2 (Lindsey 1992).

NSW — Generally occurs along the coastal margin, with numbers declining towards the south. Some inland sightings have been recorded (Morris *et al* 1981; Marchant & Higgins 1993), usually associated with large rivers or waterbodies.

Regional — Recorded in coastal areas throughout the NSW North Coast region.

Local — Observed flying over the Brunswick River on a number of occasions during the field investigations. An Osprey nest has been previously recorded (Figure 10) approximately 2km upstream of the existing Brunswick River Bridge (Milledge & McKinley 1992). This nest did not appear to be active at the time of survey and is well outside the study areas for this report.

Status

Australia — Not listed on the *ESP Act 1992*. Regarded as "*probably secure*" by Lindsey (1992), and "*secure*" by Garnett (1992b).

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species. Also regarded as "*vulnerable*" by Garnett (1992a, 1992b).

Regional — Uncommon, although the north coast is the focus of the NSW population.

Local — Present, but in low numbers, given the habit and home-range of the species.

Abundance

Described as "*sparse to locally common*" in northern Australia (Marchant & Higgins 1993). It is regarded as "*far more numerous in the north than in the south*" by Lindsey (1992), and as "*stable and well protected*" by Poole (1989). Becoming increasingly common in NSW (Debus 1994; Clancy 1991; Morris & Burton 1993), with known nest sites increasing from one in 1975, to sixty-seven in 1993 (Maciejewski 1993).

Threatening Processes

Osprey numbers in NSW and SA have been reduced through human persecution and possibly pesticide use, with higher densities occurring along the more remote coastlines, such as in Queensland, WA and the NT. Although apparently tolerant of human activity (often nesting near or within urban areas on artificial structures - Debus 1994), extensive clearing for agriculture and settlement and the degradation of clear waters essential for foraging may pose a threat to this species.

BUSH-HEN ***Amaurornis* olivaceus**

Habitat Requirements
The Bush-hen inhabits thick undergrowth of rank grass or Lantana *Lantana camara* thickets associated with permanent or semi-permanent waterbodies or streams (such as creeks, rivers, ponds, swamps, waterholes, dams, lakes, freshwater wetlands, roadside ditches - Fraser & Mendel 1976; Marchant & Higgins 1993; Muranyi 1994). The maximum distance a Bush-hen has been recorded from water is 500m (Blakers *et al* 1984), whilst the average distance is 100m (Muranyi 1994).

Distribution

Australia	Restricted to the coast and nearby ranges of Arnhem land, from the Daly River and along the Gulf of Carpentaria to Cape York, and south to the Clarence River, NSW (Schodde & Tidemann 1986). Estimated distribution of 100000 to 300000 sq.km (Lindsey 1992).
NSW	Restricted to the Northern Rivers district (Marchant & Higgins 1993), from the Tweed Heads/Murwillumbah area, south to Evans Head, and inland to Woodenbong (Muranyi 1994). One historic record exists for the Clarence River, Grafton, in 1864 (Boles 1976), with no other known records.
Regional	In the NSW North Coast region, this species is known from the Tweed, Brunswick and Richmond River Valleys (Gilmore & Parnaby 1994).
Local	The Bush-hen was not recorded during the current investigations for the proposed Bypass duplication or Pacific Highway upgrade. However, it has been recorded previously in the general locality during preliminary investigations for the upgrade of the Pacific Highway, Brunswick River to Billinudgel (Kinhill 1996) and during fauna investigations for the North Ocean Shores Local Environmental Study (BSPC 1996).

Status

Australia	Not listed on the ESP Act as a species of national conservation significance. Regarded as "*probably secure*" in Australia (Lindsey 1992).
NSW	Specified on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species. Morris *et al* (1981) listed this species as "*scarce*" in NSW.
Regional	as for State.
Local	Uncertain, due to the low number of records of this species in the general locality. Likely to be rare, given the limited areas of potential habitat.

Abundance
Morris *et al* (1981) consider this species to be "*sparse*" with an estimated population between 100 and 1000 birds in NSW.

Threatening Processes
Habitat loss, introduced predators (such as feral cats), burning practices and possibly grazing (Andrews *et al* 1994).

PIED OYSTERCATCHER ***Haematopus longirostris***

Habitat Requirements

This is a coastal species, which roosts and forages on sandy beaches, mudflats and sandbanks. Birds also roost in sheltered inlets and lagoons and occasionally mangroves (Marchant & Higgins 1993). Suitable nesting habitat for this species includes mainland sandy beaches, sand-bars and estuaries, immediately above the high water mark, as well as on sand dunes (Marchant & Higgins 1993; Lauro & Nol 1995). Whilst the movements of this species are poorly known, there is apparently some seasonal movement between the mainland and offshore islands (Marchant & Higgins 1993).

Distribution

Australia	Distributed along the entire Australian coast, including offshore islands providing suitable habitat (Marchant & Higgins 1993). Sites of significance which support substantial numbers of birds are generally in the southeastern portion of this species' distribution, and include The Coorong in southeastern SA, the Derwent River estuary in Tasmania and Corner Inlet in Victoria (Marchant & Higgins 1993).
NSW	Distributed along the entire NSW coast, including offshore islands providing suitable habitat (Marchant & Higgins 1993).
Regional	This species is likely to occur in varying abundance, along the entire coastline of the NSW North Coast region, with distribution dependent on the levels of existing disturbance, in particular human settlements, and availability of suitable roosting, nesting and foraging sites. In the NSW North Coast region, this species is known from the Tweed, Brunswick and Richmond River estuaries (Gilmore & Parnaby 1994), as well as a number of other locations.
Local	Recorded on tidal mudflats along the Brunswick River during the field investigations conducted for this report (Figure 10). Recorded during numerous fauna investigations in the general locality (Cathcart 1991; Milledge & McKinley 1992; Oehlman 1997).

Status

Australia	Not listed in the ESP Act as a species of national conservation significance. Considered "*uncommon*" (Marchant & Higgins 1993) and "*sparse*" (Lindsey 1992), but "*presently secure*" in all states, except for NSW (Garnett 1992).
NSW	Specified on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.
Regional	as for state.
Local	as for state and region.

Abundance

Considered "*sparse*" in Australia (Lindsey 1992), with an estimated minimum population of 10000 birds (Marchant & Higgins 1993). Abundance varies throughout the country, with certain areas providing a stronghold for this species. It is more abundant in the southeastern portion of its distribution, occurring in large numbers in Tasmania, Victoria and South Australia (Lindsey 1992; Lane 1987). Abundance declines further north. Populations have apparently declined in some areas, whilst at other locations numbers have increased (Marchant & Higgins 1993).

Threatening Processes

Availability of, and disturbance to, nesting sites is thought to be a primary threat to this species. Human activities, in particular the trampling of nests by walkers, horse-riders and four-wheel drives. Gulls are known predators of oystercatcher eggs, and this may impact on this species' reproductive success (Lauro & Nol 1995). Fox and feral cat predation of eggs and chicks is thought to also constitute a threatening process for this species (Marchant & Higgins 1993).

SOOTY OYSTERCATCHER ***Haematopus fuliginosus***

Habitat Requirements

The Sooty Oystercatcher is coastal, inhabiting rocky shorelines, coral cays and reefs and occasionally sandy beaches (Marchant & Higgins 1993). Unlike the Pied Oystercatcher, this species is common in areas supporting rocky headlands and cliffs (Marchant & Higgins 1993). It commonly roosts and nests on offshore islands (Marchant & Higgins 1993). Breeding sites are usually different to roosting and wintering sites, with seasonal movements of birds common (Marchant & Higgins 1993). This species forages both diurnally and nocturnally on a range of prey, including molluscs, worms, crustaceans and small fish, depending on availability (Marchant & Higgins 1993).

Distribution

Australia — Patchy distribution along the entire Australian coast, including offshore islands providing suitable habitat (Marchant & Higgins 1993). Sites of significance which support substantial numbers of this species are generally located in the southern and southeastern portions of the continent, and include the Eyre Peninsula and Kangaroo Island in South Australia, and Corner Inlet in Victoria (Marchant & Higgins 1993).

NSW — Distributed in small numbers along the entire NSW coast (Marchant & Higgins 1993). Distribution in NSW is restricted by the availability of suitable offshore roosting and breeding habitat (Marchant & Higgins 1993) and mainland rocky shorelines.

Regional — In the NSW North Coast region, this species is known from a large number of locations, including the Tweed, Cudgen and Richmond River estuaries, as well as Iluka Bluff and Cape Byron (Gilmore & Parnaby 1994). This species is likely to occur in varying abundance, along the entire coastline of the NSW North Coast region, with distribution dependent on the availability of suitable offshore breeding and roosting habitat (Marchant & Higgins 1993).

Local — Not recorded in the study area during the fauna investigations conducted for this report, but known from the general locality (NP&WS Wildlife Atlas; NSW Bird Atlassers database).

Status

Australia — Not listed in the ESP Act as a species of national conservation significance. Considered "*secure*" (Marchant & Higgins 1993) and "*probably secure*" (Lindsey 1992) in Australia, and "*presently secure*" in all states, except for NSW (Garnett 1992).

NSW — Specified on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.

Regional — as for state.

Local — as for state and region.

Abundance

The Sooty Oystercatcher is considered "*sparse*" in Australia (Lindsey 1992), with an estimated minimum population of 4000 birds (Marchant & Higgins 1993). Abundance varies throughout the country, with certain areas providing a stronghold for this species. It is more abundant in the southern portion of its distribution, occurring in large numbers in Tasmania, Victoria and South Australia (Lindsey 1992; Lane 1987) Abundance declines further north.

Threatening Processes

Unlike the Pied Oystercatcher, the Sooty Oystercatcher is less vulnerable to disturbance to nesting sites, as it usually nests on offshore islands and relatively inaccessible headlands and rocky outcrops. The loss of habitat, in particular suitable nesting and roosting sites on offshore islands, is a significant threat to this species' survival. Gulls are known predators of oystercatcher eggs, and this may impact on this species' reproductive success (Lauro & Nol 1995).

ROSE-CROWNED FRUIT-DOVE ***Ptilinopus regina***

Habitat Requirements
The Rose-crowned Fruit-Dove is a strictly arboreal bird, inhabiting sub-tropical and dry rainforest, mangroves, riverine forest, beachside scrub and eucalypt forests with rainforest elements (Lindsey 1992; Gilmore & Parnaby 1994; Higgins & Davies 1996). It prefers large expanses of forest, but does occur in smaller remnants (Higgins & Davies 1996). It feeds on a wide variety of rainforest fruits, particularly figs (Higgins & Davies 1996) and forages, roosts and nests in the upper canopy of trees (Lindsey 1992).

Distribution

Australia — The Rose-crowned Fruit-Dove occurs in northern and eastern coastal Australia, from the Kimberleys in the Northern Territory to Cape York and south to Port Stephens in NSW (Lindsey 1992; Gilmore & Parnaby 1994). Its total distributional range is estimated to be 100000-300000 km^2 (Lindsey 1992).

NSW — Within NSW, it occurs along the north coast from the Queensland border to near Port Stephens, and occasionally as far south as Sydney (Lindsey 1992). Records of this species are known from the NSW east coast, to the Hunter Valley (Gilmore & Parnaby 1994).

Regional — Records of the Rose-crowned Fruit-Dove exist for the general region on the NP&WS and the NSW Bird Atlassers databases. This species is known from a number of catchments in the NSW North Coast region, including the Tweed, Brunswick and Richmond Rivers (Gilmore & Parnaby 1994).

Local — Not recorded during the fauna surveys conducted for this report. However, this species has been previously recorded at North Ocean Shores (BSPC 1996) to the east of the proposed upgrade study area, and in the general surrounding area (NP&WS Wildlife Atlas).

Status

Australia — Not listed on the ESP Act. Regarded as "*vulnerable*" by Lindsey (1992).

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.

Regional — sparsely distributed, vulnerable.

Local — sparsely distributed, vulnerable.

Abundance
Regarded as "*sparse*" in Australia (Lindsey 1992). Recher *et al* (1995) estimates the NSW population to be between 1600 and 2000 individuals.

Threatening Processes
Clearing and fragmentation of habitat (Kikkawa 1993; Gilmore & Parnaby 1994). Visitor-disturbance at seasonally concentrated food sources (Date & Recher 1989).

WOMPOO FRUIT-DOVE ***Ptilinopus magnificus***

Habitat Requirements
The Wompoo Fruit-Dove is a large arboreal pigeon which is almost exclusive to rainforest (Lindsey 1992; Gilmore & Parnaby 1994). It feeds on a variety of rainforest fruits, preferring relatively large and undisturbed tracts of rainforest in which it can be difficult to locate (Date & Recher 1989; Lindsey 1992; Higgins & Davies 1996). The dense canopy of rainforest trees is preferred for roosting and nesting, with nests being constructed in the outer foliage (Lindsey 1992; Higgins & Davies 1996).

Distribution

Australia	The Wompoo Fruit-Dove occurs along the east coast of Australia from the tip of Cape York (Qld) in the north, to near Newcastle (NSW) in the south (Lindsey 1992). Its total distributional range is estimated to be 100000-300000 km^2 (Lindsey 1992).
NSW	The Wompoo Fruit-Dove occurs along the coast of NSW, from the Queensland border south to the Illawarra district, rarely being recorded south of Newcastle (Lindsey 1992).
Regional	Recorded on the NP&WS Wildlife Atlas and the Birds Australia and the NSW Bird Atlassers databases for the general region. Known from the Tweed, Brunswick and Richmond Valleys (Gilmore & Parnaby 1994).
Local	Known from the Brunswick River Valley (NPWS Wildlife Atlas; Birds Australia and Bird Atlassers databases; Gilmore & Parnaby 1994) and recorded previously at Taggert's Hill (MKES 1994) to the north of the upgrade study area. Not recorded during the fauna surveys conducted for this report.

Status

Australia	Not listed on the ESP Act. Regarded as "*vulnerable*" by Lindsey (1992).
NSW	Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.
Regional	sparse, vulnerable.
Local	sparse, vulnerable.

Abundance
Regarded as "*sparse*" in Australia by Lindsey (1992). Recher *et al* (1995) estimates that the NSW population probably exceeds 7000 individuals. Widely distributed in rainforest in northeastern NSW, but apparently in low numbers.

Threatening Processes
Clearing and fragmentation of habitat (Lindsey 1992; Kikkawa 1993). Human activity including walking track use and vehicular traffic may prevent breeding (Date & Recher 1989). This species has a low reproductive rate (Frith 1982).

SUPERB FRUIT-DOVE ***Ptilinopus superbus***

Habitat Requirements
The Superb Fruit-Dove inhabits rainforest and adjacent eucalypt forest and mangroves along the eastern coast of Australia, primarily from the tip of Cape York to Rockhampton, with vagrants reaching southeastern Victoria and Tasmania (Lindsey 1992). It prefers coastal lowland forest, being strongly arboreal and feeding on a variety of rainforest fruits, particularly laurels (Lindsey 1992). It is generally recorded at the warmest rainforest sites, and usually below 300m asl (Gilmore & Parnaby 1994). Nests are constructed in dense foliage up to to 30m above the ground (Lindsey 1992)

Distribution

Australia	The Superb Fruit-Dove occurs along the east coast of Australia, from the tip of Cape York to Tasmania (Higgins & Davies 1996; Lindsey 1992). It has an estimated distributional range of 100000-300000 km^2 (Lindsey 1992).
NSW	The Superb Fruit-Dove occurs along coastal areas of the northern rivers region of NSW, becoming rarer to the south (Higgins & Davies 1996). This species is known from a number of valleys in NSW, including the Tweed, Brunswick, Clarence, Richmond, Macleay and Hunter river catchments (Gilmore & Parnaby 1994).
Regional	This species has been recorded at Linwood to the south of the study area and at Inner Pocket to the northwest (NP&WS Atlas). It is known from a number of rivers in the NSW North Coast region, including the Tweed, Brunswick, Clarence, Richmond, Macleay and Hunter Rivers (Gilmore & Parnaby 1994).
Local	Not recorded during the fauna surveys conducted for this report. However, this species has been recorded previously in the Brunswick River Valley (NPWS Wildlife Atlas; Gilmore & Parnaby 1994), and could potentially occur in the general vicinity given the presence of suitable habitat.

Status

Australia	Not listed on the ESP Act. Regarded as "*vulnerable*" by Lindsey (1992).
NSW	Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.
Regional	Known to occur in low numbers.
Local	If present, this species is likely to be rare, given the absence of sightings during numerous previous investigations in the general locality.

Abundance
Regarded as "*sparse to common*" in Australia by Lindsey (1992), this species is more abundant in the northern portion of its range, becoming more sparse further south (Gilmore & Parnaby 1994).

Threatening Processes
Clearing and fragmentation of habitat (Lindsey 1992; Kikkawa 1993; Gilmore & Parnaby 1994). It is necessary to protect corridors which allow altitudinal and north-south migrations (Date & Recher 1989).

COLLARED KINGFISHER ***Halcyon chloris***

Habitat Requirements
The Collared or Mangrove Kingfisher is a poorly known species. It inhabits mangroves where it nests in termite mounds (Gilmore & Parnaby 1994), with tree-hollows and earthern banks used on occasions (Lindsey 1992). Each family group has strongly defined territory (Bell 1960) of around 1.5ha (Gilmore & Parnaby 1994). This species has been observed feeding on lizards and crabs (Bell 1960).

Distribution

Australia	Distributed along the north and central Australian coast, from approximately Shark Bay in Western Australia to Port Macquarie in NSW (Lindsey 1992).
NSW	Distributed along the NSW coast from its border with Queensland to approximately Port Macquarie.
Regional	This species' distribution includes the study area and coastal habitats throughout the NSW North Coast region. In the region, this species is known from the Tweed, Brunswick and Richmond River Valleys (Gilmore & Parnaby 1994).
Local	Although not recorded during the fauna investigations conducted for this report, this species is known from the Brunswick River estuary (Gilmore & Parnaby 1994) and has been recorded previously in the general vicinity of the proposed upgrade study area (Kinhill 1996). Local distribution is restricted to mangrove communities and associated tidal flats and pools.

Status

Australia	Not listed on the ESP Act as a species of national conservation significance. Considered "*secure*" in Australia (Lindsey 1992), and "*presently secure*" in all Australian states but NSW (Garnett 1992).
NSW	Specified on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.
Regional	as for state
Local	as for state and region.

Abundance
Abundance is considered "*sparse to common*" (Lindsey 1992).

Threatening Processes
Threats to this species are unknown, but are likely to include the loss of suitable mangrove habitat and predation of young from the nest.

MANGROVE HONEYEATER ***Meliphaga fasciogularis***

Habitat Requirements
The Mangrove Honeyeater is a little known species. It inhabits estuarine closed mangrove forest where it roosts and nests in horizontal forks (Gilmore & Parnaby 1994). Whilst generally sedentary, individuals may wander locally in search of flowering plants, including flowering shrubs in towns adjacent to mangrove communities (Blakers et al 1984). It feeds on nectar, insects, molluscs and crabs.

Distribution

Australia — Restricted distribution along the eastern Australian coast, from approximately Townsville in the north to Port Macquarie in NSW (Lindsey 1992). This species' distribution is thought to encompass between 100000 and 300000 km^2 (Lindsey 1992).

NSW — Restricted and patchy distribution along the NSW coast from its border with Queensland to approximately Port Macquarie. Distribution is restricted by the availability of suitable mangrove habitat.

Regional — This species' distribution includes the study area and coastal habitats throughout the NSW North Coast region. It is known from the Tweed, Brunswick, Richmond, Clarence, Macleay and Hastings River Valleys (Gilmore & Parnaby 1994). Distribution is restricted by the availability of suitable mangrove habitat.

Local — Although not recorded during the fauna investigations conducted for this report, this species is known from the Brunswick River estuary (Gilmore & Parnaby 1994) and has been recorded previously in the general vicinity of the proposed upgrade study area (Kinhill 1996). Local distribution is restricted to mangrove communities.

Status

Australia — Not listed on the ESP Act as a species of national conservation significance. Considered "*probably secure*" in Australia (Lindsey 1992)

NSW — Specified on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.

Regional — as for state.

Local — as for state and region.

Abundance
Abundance is considered "*common*" (Lindsey 1992), although primarily in the northern parts of its distribution.

Threatening Processes
Threats to this species are unknown (Gilmore & Parnaby 1994), but are likely to include the loss of suitable mangrove habitat.

KOALA ***Phascolarctos cinereus***

Habitat Requirements
Koalas generally inhabit open eucalypt forests and woodlands which contain a variety of 'preferred' food tree species, depending on locality and seasonal conditions. Koalas have been recorded feeding or resting in a total of 120 species of eucalypt, as well as 40 other tree species (Lee & Martin 1988; Reed & Lunney 1990; Phillips 1990). Of the eucalypts present in the study area, species of greatest relevance for the Koala include Tallow-wood *Eucalyptus microcorys*, Forest Red Gum *Eucalyptus tereticornis* and Swamp Mahogany *Eucalyptus robusta* (Lee & Martin 1988; Reed & Lunney 1990; Pahl *et al* 1991).

Distribution

Australia — The range of the Koala has been reduced by as much as 50-90% since European settlement in Australia (Kennedy 1992). The Koala currently occurs throughout eastern Australia, from the western side of Victoria to the base of Cape York, in a series of large but disjunct populations, with major concentrations in southeastern Queensland, northeastern NSW and in Victoria (Phillips 1990). Its current distributional range is estimated to be 300000 to 1 million km^2 (Strahan 1995);

NSW — Within NSW, Koala populations are concentrated in the northeastern corner of the state (Phillips 1990), with foci of Koala density located in the Port Stephens, Port Macquarie, Coffs Harbour and Tweed Shire areas (Phillips 1990; Reed & Lunney 1990). The Koala is sparsely located over remaining coastal areas (Strahan 1995).

Regional — The Koala occurs in the Tweed, Brunswick, Richmond, Clarence, Bellinger, Macleay, Hastings, Camden Haven, Manning and Hunter Valleys in the NSW North Coast region (Gilmore & Parnaby 1994).

Local — This species is known to occur widely through sparsely throughout the general locality, and has been recorded at locations north and south of the Brunswick River (Milledge & McKinley 1992; Kinhill 1996; BSPC 1996; Oehlman 1997; this investigation). Two Koalas were recorded in the vicinity of Banana Road during spotlighting surveys conducted for this investigation (Figure 10).

Status

Australia — Not listed on the ESP Act. Regarded as "*probably secure*" (Strahan 1995).

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.

Regional — Concentrated in the portions of the region with localised densities.

Local — Uncommon and generally widespread at low densities through the locality.

Abundance
The Koala has experienced significant fluctuations in population numbers over the last 200 years, with periods of hunting and associated population declines into the early 1900s, intermittent periods of apparent population increases, and a considerable history of habitat modification and degradation (Phillips 1990; Reed *et al* 1991). It is very sparse through its broad distribution (Martin & Handasyde 1995), and is abundant only in a few locations across its range (Reed *et al* 1991).

Threatening Processes
Koala populations appear at greatest risk along the north coast of NSW, with threats including modification, fragmentation and loss of habitat from rapid urbanisation, and increased exposure to other associated hazards such as dogs, cars, swimming pools, bushfires and disease (Phillips 1990; Maxwell *et al* 1996). The distribution of Koalas has been closely linked to the occurrence of tree species which grow on high nutrient soils, such as in river valleys (Reed *et al* 1991). These areas have traditionally been cleared due to their suitability for agriculture, with most National Parks and Nature Reserves occurring on poorer soils and steep slopes.

SQUIRREL GLIDER ***Petaurus norfolcensis***

Habitat Requirements

This species is a small arboreal marsupial, inhabiting dry sclerophyll forest and woodland, including Box-Ironbark, Blackbutt-Bloodwood, Grey Gum-Grey Ironbark-Spotted Gum and River Red Gum communities (Suckling 1995; Maxwell *et al* 1996). Where it inhabits mixed species stands, there are invariably some smooth-barked and high nectar-producing species present (Menkhorst *et al* 1988). It is also known to inhabit tall coastal forest and banksia woodland in the northeast of its distribution (Maxwell *et al* 1996), but does not occur in raiforest or mesic habitats. The Squirrel Glider appears to partition suitable habitat spatially with the Sugar Glider *Petaurus breviceps*, with the Squirrel Glider feeding in the upper canopy and the Sugar Glider at lower levels (Davey 1984). The Squirrel Glider feeds predominantly on nectar and pollen, supplementing its diet with sap, invertebrates and the seeds of the Golden Wattle (Suckling 1995). It is dependent on the presence of medium sized tree-hollows for shelter and nesting (Suckling 1995).

Distribution

Australia — The Squirrel Glider occurs in a broad band along the east coast of Australia, including coastal Queensland south of the Cape York Peninsular, through coastal NSW to central Victoria (Strahan 1995). Its total distributional range is estimated to be 300000 to 1 million km^2 (Strahan 1992).

NSW — In northern NSW, the Squirrel Glider is coastal in distribution, while in southern NSW it occurs further inland (Suckling 1995).

Regional — In the NSW North Coast region, this species is known from the Tweed, and Richmond, Clarence, Macleay, Hastings and Hunter River catchments (Gilmore & Parnaby 1994).

Local — A Squirrel Glider was recorded during spotlighting surveys east of the existing Brunswick Heads Bypass alignment during the field investigations (Figure 10). This species has been recorded previously within 10km of the Bypass and upgrade study areas (NP&WS Wildlife Atlas), but has not been recorded during numerous previous investigations in the immediate vicinity.

Status

Australia — Not listed on the ESP Act. "*The Squirrel Glider may be endangered in the southern part of its range*" (Suckling 1995).

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act* 1995 as a Vulnerable species.

Regional — as for state

Local — as for state

Abundance

Listed as "*rare*" in Strahan (1995). Recent records of the Squirrel Glider from coastal areas, including Sydney, the Central Coast, Port Stephens and Coffs Harbour, indicate that the species is more widespread and abundant than originally thought. It is likely that a significant number of earlier records east of the Great Dividing Range attributed to the Sugar Glider have in fact been of the Squirrel Glider. Apparently more abundant in coastal forests of northern NSW than inland or in the southern parts of its range (Maxwell *et al* 1996).

Threatening Processes

Threats to the Squirrel Glider include habitat clearing for agriculture, continued grazing and forestry operations which have reduced the abundance of tree-hollows (Suckling 1995; Menkhorst *et al* 1988). The Squirrel Glider is known to utilise disjunct roadside and creekside remnants, the preservation of which may be vital for its continued survival in some areas (Suckling 1995).

QUEENSLAND BLOSSOM BAT ***Syconycteris australis***

Habitat Requirements
The Queensland Blossom Bat has a highly specialised diet of pollen and nectar, with critical foraging habitat including heathland and melaleuca swamps supporting favoured foods such as *Banksia*, *Melaleuca*, *Callistemon* and *Eucalyptus* species. The Coast Banksia *Banksia integrifolia* appears to be a key food source (Gilmore & Parnaby 1994) during winter.. Coastal rainforest is particularly important, providing moist daytime roost sites in the sub-canopy (Law & Spencer 1995).

Distribution

Australia — The Queensland Blossom Bat occurs along the eastern coast of the continent from the Cape York Peninsula in the north to near Newcastle in the south (Law & Spencer 1995). It is estimated to occupy a total distributional range of 100000 to 300000 km^2 (Law & Spencer 1995).

NSW — It occurs along the NSW coast, from the Queensland border to Booti Booti near Newcastle (Law & Spencer 1995; Gilmore & Parnaby 1994).

Regional — The Queensland Blossom Bat has been recorded previously at a number of locations in northeastern NSW, north and south of the study areas (Milledge 1991; NP&WS Wildlife Atlas; Tanton 1996). Although not recorded during surveys in the Dorrigo, Walcha-Nundle and Styx River, Urbenville, Coffs Harbour-Urunga and Casino Management Areas, the Queensland Blossom Bat was recently recorded during surveys in the nearby Murwillumbah Management Area (CSIRO 1996; Tanton 1996).

Local — Recorded at two locations (along the proposed Bypass and just north of Brunswick Heads NR - west of the existing Highway) during the field surveys (Figure 10). Recorded at a number of locations north and south of the Brunswick River during previous investigations (Gilmore & Associates 1995; Milledge & McKinley 1992; MKES 1994; BSPC 1996).

Status

Australia — Not listed on the ESP Act. Described as "*probably secure*" by Strahan (1995).

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.

Regional — Uncommon, but locally common where suitable habitat occurs.

Local — Unknown; likely to be locally common in areas of suitable habitat in the general vicinity, particularly along the coast.

Abundance
Regarded as "*common*" in Australia (Law & Spencer 1995), and "*common in limited habitat*" by Law & Spencer (1995).

Threatening Processes
Loss of food resources and roosting sites from sandmining and development (Gilmore & Parnaby 1994). Weed-infestation suppresses the growth of food trees, such as *Banksia integrifolia*, which is likely to be a critical resources due to its extended winter flowering period (Gilmore & Parnaby 1994).

GREATER BROAD-NOSED BAT ***Scoteanax rueppellii***

Habitat Requirements
The Greater Broad-nosed Bat inhabits eucalypt forests and woodlands, particularly more open communities which suit its relatively direct flight patterns (Hoye & Richards 1995). It generally feeds by flying slowly at low heights, along tree-lined creeks (including through rainforest) and along the ecotone between cleared land and woodland (Hoye & Richards 1995). Most records for this species are taken from sclerophyll forest and in woodland habitats, rather than rainforest (Gilmore & Parnaby 1994).

Distribution

Australia — The Greater Broad-nosed Bat occurs throughout coastal eastern Australia from southern NSW to Ingham, Queensland (Hall & Richards 1979). Strahan (1995) comments that the range of this species is from northeastern Victoria to the Atherton Tableland in Queensland where it occurs in the gully and river systems which drain the Great Dividing Range. Its total distributional range is estimated to be 100000 to 300000 km^2 (Strahan 1992).

NSW — Restricted to the Great Dividing Range and east of the range (Parnaby 1994).

Regional — This species is sparse but widely distributed throughout the NSW North Coast region (Gilmore & Parnaby 1994).

Local — This species was tentatively identified (possible identification) from Anabat II echolocation recordings along the proposed Bypass duplication alignment (Figure 10). Recorded previously in the immediate vicinity (Milledge & McKinley 1992) and in the surrounding area (NP&WS Wildlife Atlas).

Status

Australia — Not listed on the ESP Act. Regarded as "*uncommon to rare*" in Strahan (1995); considered by Hoye & Richards (1995) as "*uncommon to rare*".

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act 1995* as a Vulnerable species.

Regional — as for state

Local — as for state and region

Abundance
The abundance of this species is considered "*very sparse*" by Strahan (1992), and "*uncommon to rare*" by Richards (1991). In regional terms, this species is considered to be sparse but widely distributed (Gilmore & Parnaby 1994).

Threatening Processes
Habitat modification and destruction, including loss of hollow-bearing trees and foraging habitat. Application of pesticides may also constitute a threatening process.

LITTLE BENT-WING BAT ***Miniopterus australis***

Habitat Requirements
The Little Bent-wing Bat is a cave-dwelling species, requiring specific nursery sites to rear its young (Dwyer 1995). This species has been recorded roosting in mines, disused railway tunnels and stormwater drains, often sharing roost sites with the Large Bent-wing Bat *Miniopterus schreibersii* (Hall & Richards 1979). It inhabits well timbered rainforest and dry sclerophyll habitats, foraging for small insects beneath the canopy (Dwyer 1995).

Distribution

Australia — The Little Bent-wing Bat occurs along the eastern coast of Australia, from the northern tip of the Cape York Peninsula in Queensland to approximately the Hawkesbury River (Hall & Richards 1979; NP&WS Wildlife Atlas). Its total distributional range is estimated to be 300000 to 1 million km^2 (Strahan 1992),

NSW — The published distribution of the Little Bent-wing Bat is along the east coast of NSW, from the Queensland border to Kempsey (Hall & Richards 1979). However, this species is known from areas substantially further south, including the study area and the Hawkesbury area (NP&WS Wildlife Atlas).

Regional — Recorded at numerous locations throughout the NSW North Coast region. This species' distribution is likely to reflect the availability of specific habitat resources, in particular suitable roosting and maternity caves.

Local — This species was tentatively recorded from Anabat II echolocation recordings along Banana Road, in the Brunswick to Yelgun study area (Figure 10). Recorded previously at a number of locations north of the Brunswick River (MKES 1994; BSPC 1996) and along the Brunswick Heads Bypass (Milledge & McKinley 1992) to the south.

Status

Australia — Not listed on the ESP Act. Considered to be "*secure*" (Strahan 1992).

NSW — Listed on Schedule 2 of the *NSW Threatened Species Conservation Act* 1995 as a Vulnerable species.

Regional — as for state.

Local — as for state and region.

Abundance
The Little Bent-wing Bat is described by Parnaby (1992) as "*localised and common*", and by Strahan (1992) and Dwyer (1995) as "*abundant*".

Threatening Processes
The Little Bent-wing Bat relies on a few relatively large communal nursery caves, which are often used annually, and which are believed to contain a large proportion of the species' population during the breeding season (Dwyer 1995). Disturbance of these roosting sites is a threat to the long-term survival of this species. Frequent disturbance to roosts used for hibernation increases winter mortality (Dwyer 1995). The loss of native vegetation used as a foraging resource is also a threat to the continued survival of this species.

EASTERN LONG-EARED BAT ***Nyctophilus bifax***

Habitat Requirements
This species occurs in a range of habitats, including rainforest, dry sclerophyll forest and riparian communities. Although little is known about the biology and habits of the Eastern Long-eared Bat, it is known to roost in tree-hollows and dense vegetation, particularly rainforest. It is thought to forage for insects amongst foliage.

Distribution

Australia	The Eastern Long-eared Bat occurs across the north coast of Australia, including an isolated sub-species on the west coast of WA, and along the east coast from Cape York to northern NSW. Its total distributional range is estimated to be more than 1 million km^2 (Strahan 1992),
NSW	In NSW, the distribution of the Eastern Long-eared Bat is restricted to the northeastern corner of the state (Gilmore & Parnaby 1994).
Regional	This species reaches its southern distributional limit in the NSW North Coast region, with no known records south of Iluka (Gilmore & Parnaby 1994).
Local	This species was recorded during harp trapping surveys in both the proposed Brunswick Heads Bypass duplication and the Pacific Highway upgrade, Brunswick to Yelgun, study areas (Figure 10). It has also been recorded in the general locality during previous fauna investigations (Milledge & McKinley 1992; MKES 1994; BSPC 1996; NP&WS Wildlife Atlas).

Status

Australia	Not listed on the ESP Act. Considered to be "*common, widespread in the coastal tropics*" (Parnaby 1995) and "*probably secure*" (Strahan 1992).
NSW	Listed on Schedule 2 of the *NSW Threatened Species Conservation Act* 1995 as a Vulnerable species.
Regional	as for state.
Local	as for state and region.

Abundance
The Eastern Long-eared Bat is described by Parnaby (1995) as "*common*" and "*localised*", and by Strahan (1992) as "*common*".

Threatening Processes
The Eastern Long-eared Bat relies on the presence of tree-hollows and dense foliage, particularly rainforest, for roosting and nesting (Parnaby 1995). The loss of native vegetation is a threat to the continued survival of this species.

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 8

Propagation Details for Plant Species of Conservation Concern

(Source: Burringbar Rainforest Nursery)

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APPENDIX 8 Propagation details for the plant species of conservation concern recorded during field investigations for the proposed upgrade of the Pacific Highway, Brunswick to Yelgun. Propagation details are provided by L FitzGerald of Burringbar Rainforest Nursery, Burringbar, NSW.

Species	**Likelihood of successful germination**	**Comments**
Category 1 - Species that provide reliable germination from seed from freshly collected fruit		
Davidsonia pruriens subsp *jerseyana*	100%	There are usually 2 viable seeds in each drupe-like fruit. December. Most trees reliably fruit each season.
Endiandra floydii	100%	Single-seeded large drupe. December. Not always available as this rare tree does not set fruit every year.
Endiandra muelleri subsp *bracteata*	80%	Single-seeded small drupe. Probably not available locally. Burringbar Nursery's source is from central Queensland trees.
Randia moorei	80%	Fruit is a small berry containing numerous seeds. May. Usually reliable, although the amount of fruit set varies widely each year.
Cryptocarya foetida	60%	Fruit is a small single-seeded drupe. August. Trees do not set fruit every year and amount varies considerably.
Syzygium hodgkinsoniae	90%	Large single seed containing berry. September. Usually available. Seedlings are difficult to establish owing to red bud mite that always affects the growing tips.
Syzgium moorei	70%	Single seed containing berry. March. Large crops readily available.
Cupaniopsis newmanii	80%	Fruit is a three-lobed capsule usually containing 1 or 2 viable seeds. October. Most years readily available, although amount produced each year varies widely.
Endiandra globosa	90%	Fruit is a single-seeded large drupe. April. A common tree that usually produces abundant fruit each year.
Archidendron muellerianum	100%	Fruit is a pod containing about 5 seeds. Variable. Trees only occasionally form pods and, although germination is easy, seedlings are inevitably infected with a leaf-blemishing fungus that inhibits growth.
Acacia bakeri	90%	Seed is in pods. January. Unreliable. Trees occasionally set large crops. For this wattle, hot water treatment is to be avoided.
Planchonella chartacea	80%	Small single-seeded drupe. September. Rarely available as trees only occasionally set fruit.
Planchonella laurifolia	70%	Single-seeded drupe. July. Normally only small amounts available and fruit production appears rather erratic.
Grevillea hilliana	60%	Each follicle usually contains 2 viable seeds. Locally sourced seed is not usually available owing to scarcity of mature trees in this area. Cultivated trees occasionally set fruit.
Category 2 - Species that are not readily germinated from seed		
Elaeocarpus williamsianus	-	Fruit is a large drupe which should theoretically contain a number of seeds. Fruit is ripe for harvesting in December. Burringbar Nursery has attempted to propagate this tree from locally collected seed for some years now, but have yet to meet with any success. However, this species has been successfully propagated from cuttings, which is the recommended method for this species.
Category 3 - Unknown		
Xylosma terraereginae	?	Burringbar Nursery has yet to observe fruit on this rare littoral rainforest tree in the area.

PROPOSED DUPLICATION
of the BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK to YELGUN

APPENDIX 9

Threatened Species
Assessment of Significance under Section 5A
of the
Environmental Planning & Assessment Act 1979.

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PROPOSED DUPLICATION of the BRUNSWICK HEADS BYPASS
and
UPGRADE of the PACIFIC HIGHWAY, BRUNSWICK RIVER to YELGUN

Section 5a Assessment of Significance
***NSW Environmental Planning & Assessment Act* 1979**

July 1998

1 INTRODUCTION

1.1 General

The NSW *Threatened Species Conservation Act 1995* (TSC Act) has modified the *Environmental Planning & Assessment Act 1979* (EP&A Act) by including in Section 5A (s.5A) eight factors which are to be considered when determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*". These factors "*must be taken into account*" by a consent or determining authority when considering a Development Application or development proposal, in administering sections 77, 90 and 112 of the EP&A Act.

This document provides an individual s.5A Assessment of Significance for each of the threatened fauna and flora species recorded along the proposed Brunswick Heads Bypass Duplication and upgrade of the Pacific Highway between Brunswick and Yelgun ('the proposal'), and species which are considered likely or potentially to be significantly affected by the project.

Consideration of s.5A of the EP&A Act for each of the individual threatened species of relevance along the proposal involves a number of assumptions and premises, as does the determination of which threatened species are of relevance. Several of the factors in s.5A cannot currently be addressed (as discussed below). Of particular relevance in this regard are issues including:

- the definition of "*a viable local population*" of several of the threatened species (Section 1.2);
- the relevance of "*endangered populations*" (Factor b) and "*endangered ecological communities*" (Section 1.3);
- the relevance of "*critical habitat*" (Factor e - Section 1.4);
- the adequacy of representation of threatened species in "*conservation reserves*" (Factor f - Section 1.7), and the definition of "*a threatening process*" (Factor g - Section 1.5).
- the definition of "*the region*" (Section 1.6);

1.2 Viable Local Population

For many of the threatened species which do or may occur along or in the vicinity of the proposal, the definition of "*a viable local population*" is problematic. In the first instance, the data available for most of the relevant species is inadequate. Furthermore, for wide-ranging fauna species, particularly those which are widely distributed but at low density, it is not certain that a valid or meaningful definition of "*viable local population*" can be determined. Similarly, it is not clear what would constitute "*a viable local population*" (emphasis added) of a migratory or nomadic species.

Similarly, determining the presence or otherwise of "*a viable local population*" of threatened plants can be difficult, particularly in instances where the only representatives present at a location are individuals or juvenile specimens.

Whilst the TSC Act does not provide a definition for "*a viable local population*", it does provide a definition for "*population*". In s.4, the TSC Act defines "*population*" as "*a group of organisms, all of the same species, occupying a particular area*". On the basis of this definition, the presence of a single individual of a threatened species clearly does not constitute a "*population*", and cannot therefore reasonably be considered to constitute "*a viable local population*". Furthermore, Population Viability Analysis and other ecological theory and considerations suggest that for a population of any organisms to be considered "*viable*", numbers of individuals ranging from about 100 to several thousand need to be present.

In this regard, difficulties arise with the definition of a "*viable local population*" for many of the threatened fauna and flora species known to occur along the Route A2 alignment, or which are likely to be present on occasions in this locality. Of relevance in this regard are considerations concerning:

- the Osprey - whether one individual or a pair of this species along the Brunswick River would constitute "*a viable local population*";
- the microchiropteran bats. Given their wide-ranging natures and habits, whether it is possible to define a discreet "*local population*", separate from the metapopulation or overlapping populations likely to be located throughout the region, and whether there is "*a viable local population*" of relevance to the proposal;
- the Pied Oystercatcher, which is relatively wide-ranging and restricted to specific habitats in the locality. As only one or a few individuals of this species at most are likely to occur near or on the alignment, it is not apparent that "*a viable local population is present*";
- the rainforest pigeons, some of which are seasonal migrants and move considerable distances (perhaps over 100km), probably occurring in the vicinity of the proposal only at certain times of the year. Thus, determination of the "*particular area*" occupied by these species is problematic; and
- several of the threatened plant species, which are present either only as individuals or only as juvenile plants.

As a consequence of the difficulties described above with respect to the definition of "*a viable local population*" of many of the threatened fauna and flora species known from the locality, or which could occur in the vicinity, a 'conservative' approach has been adopted for the Pacific Highway proposal at Brunswick Heads, and for the s.5A Assessments of Significance for individual species. Where an individual threatened species has been recorded along the corridor, the assumption has been made that "*a viable local population*" of that species is likely to be present in the vicinity, even if only a single individual has been located. Conversely, it is not assumed that such a population would be dependent solely or particularly upon the habitats and resources present along the corridor.

1.3 Endangered Populations and Ecological Communities

"*Endangered populations*" are those listed in Part 2 of Schedule 1 of the TSC Act. With respect to the Pacific Highway proposal at Brunswick Heads, there is no relevant "*endangered population*" of any species declared under the TSC Act. Consequently, Factor (b) of the s.5A Assessment of Significance cannot be relevantly addressed.

Similar considerations apply to endangered ecological communities. The TSC Act defines an "*endangered ecological community*" as "*an ecological community specified in part 3 of schedule 1*" of the Act. No relevant "*ecological community*" has been so defined by the NSW Scientific Committee, and consideration of the proposal with respect to potential impacts upon "*endangered ecological communities*", under Section 5A of the EP&A Act, cannot be relatively addressed.

1.4 Critical Habitat

The TSC Act defines "*critical habitat*" as "*habitat declared to be critical habitat under Part 3*" of the Act. It is a requirement of the Act that the Director-General of the NSW National Parks & Wildlife Service (NP&WS) declare "*critical habitat*" for "*threatened species, populations or ecological communities*".

At the time of preparation of this report, no "*critical habitat*" for any such "*species, populations or ecological communities*" had been declared by the Director-General of the NP&WS. Consequently, it is not possible to address the issue of "*critical habitat*" with respect to the Pacific Highway proposal at Brunswick Heads.

1.5 Threatening Processes

The TSC Act defines "*threatening process*" as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species populations or ecological communities*". Schedule 3 of the TSC Act is intended to provide a list of the "*key threatening processes*" which are regarded as of relevance to the Act.

Three "*key threatening processes*" have been or are being listed by the NSW Scientific Committee - predation by the European Red Fox *Vulpes vulpes* (Final Determination), the removal of bush rock (Preliminary Determination), and predation by the Plague Minnow *Gambusia holbrooki* (Preliminary Determination). Whilst the Pacific Highway proposal at Brunswick Heads may involve some very limited removal of bush rock, the project will not affect predation by the European Fox or Plague Minnow in the locality. Neither of these activities are a part of "*the development or activity*", and it is not intended, or likely, that the project will exacerbate any of these "*threatening processes*".

The construction and maintenance of roads is not included on Schedule 3 of the TSC Act, and is consequently not "*recognised as a threatening process*". However, the construction of major roads through areas of native vegetation and natural habitats may constitute "*a threatening process*" for individual species in general terms, as a result of direct or indirect impacts. The removal of vegetation, habitats and resources, the imposition of barriers to fauna movement, the fragmentation of natural habitats, and the imposition of indirect impacts (such as altered hydrologic regimes, contaminant discharge) can impose threats to the conservation of native flora and fauna.

These issues have been recognised with respect to the proposal, and are discussed in detail in the main Flora & Fauna Assessment Report (GECon 1998). Furthermore, consideration of the potential "*threatening processes*" which may be imposed by the Pacific Highway proposal at Brunswick Heads have been incorporated into impact amelioration and environmental management measures which are to be implemented as part of the project.

1.6 The Region

The TSC Act defines "*region*" as "*a bioregion defined in a national system of bioregionalisation that is determined (by the Director-General by order published in the Gazette) to be appropriate for those purposes*". The Director-General of the NSW NP&WS has given notice that the Interim Biogeographic Regionalisation of Australia (IBRA 1995), published by the Australian Nature Conservation Agency (now Environment Australia), is the appropriate definition of "*region*" for the TSC Act (Government Gazette No 65 - 24 May 1996).

According to the IBRA (1995), the Pacific Highway proposal at Brunswick Heads is located in the NSW North Coast region, which comprises the coastal portion of northeastern NSW, north from Port Stephens to the Queensland border, with the western boundary being defined approximately by the Great Dividing Range. The NSW North Coast region occupies an area of approximately 58189km^2 in NSW.

1.7 Conservation Reserves

The NSW North Coast Region (IBRA 1995) contains a relatively large number of dedicated National Parks (NPs) and Nature Reserves (NRs). The majority of these are located along the eastern fall of the Great Dividing Range to the northwest and southwest of the proposal (*eg* the Mount Warning, Mount Jerusalem and Nightcap NPs, and the Inner Pocket and Big Scrub NRs), or occur on the coastal fringe to the north and south (the Cudgen, Billinudgel, Brunswick Heads, Tyagarah and Broken Head NRs).

Two Nature Reserves are located in the immediate vicinity of the Pacific Highway proposal at Brunswick Heads, with the Brunswick Heads NR located along the northern side of the Brunswick River (in the centre of the proposal), and the Billinudgel NR located to the east of the proposal (at its northern extremity). As discussed in detail in the Flora & Fauna Assessment Report, the proposal has been designed to avoid the Billinudgel NR, but will require some limited impacts upon the Brunswick Heads NR, including a need to excise small portions of this Nature Reserve for construction of the roadway.

1.8 Relevant Species

A determination as to "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*" as a result of the proposal is documented below, individually for each of the threatened fauna and flora species considered of relevance to this project. Species considered of relevance with respect to the potential impacts of the proposal include those threatened fauna and flora species which have been recorded in the vicinity of Route A2 during field investigations for this project, and those species which, whilst not recorded along the Route A2 alignment, are regarded as both reasonably likely to occur on occasion and potentially to be affected by the proposed activity.

The relevant threatened fauna and flora species (Table 1) are a subset of a more comprehensive list of such species which are known from the region in which the proposal is located, or species which have distributional ranges which include these areas. The full list of threatened species was derived from several sources, including:

- threatened species listed on the NSW National Parks & Wildlife Service (NP&WS) Wildlife Atlas for the relevant 1:100 000 map sheets;
- previous biological investigations conducted in the surrounding area, including for the Brunswick Heads Bypass and Ocean Shores development;
- searches of relevant scientific literature; and
- the Birds Australia (Royal Australasian Ornithologists Union) database.

Threatened species which are considered of relevance with respect to the potential for adverse impacts to be imposed by the proposal, and which consequently are addressed in an individual s.5A Assessment of Significance, include:

- species recorded along Route A2 or close to it during the field investigations for this report;
- species recorded in the immediate vicinity which are considered likely to occur along Route A2 because of the presence of suitable habitats or resources, in spite of existing disturbance or habitat modification; and
- species not recorded in the immediate vicinity but which are known to occur in the locality, and for which suitable habitat will be affected to a significant extent by the proposal.

For the latter species, and indeed for some of the species which have been recorded along Route A2, it is not possible to determine whether "*a viable local population*" is present along the alignment or is likely to be significantly affected by the proposal (as discussed above).

Furthermore, it is necessary to consider the likelihood of "*a significant effect*" being imposed on any such population, by the proposed activity. In this regard, unless there is a high likelihood that "*a viable local population*" of any of the threatened species is dependent for its survival on those habitats and resources which are to be affected by the proposed activity, it can not reasonably be concluded that any such population would be "*placed at risk of extinction*" or that "*a significant effect*" would be imposed. Thus, those fauna and flora species regarded as of relevance (Table 1) include only those species which are considered likely to utilise the habitats and resources to be affected by the proposed activity, and for which there is a real possibility of "*a significant effect*" being imposed. Those species (Table 1) considered under s.5A of the EP&A Act (Section 3 below) are addressed on the assumption that there is "*a viable local population*" present, notwithstanding the absence of evidence, in most instances, for such a population.

Table 1 Threatened species considered of relevance to the proposed Pacific Highway upgrade project at Brunswick Heads.

Threatened Fauna Species		**Threatened Flora Species**	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Koala	*Phascolarctos cinereus*	Stinking Cryptocarya	*Cryptocarya foetida*
Squirrel Glider	*Petaurus norfolcensis*	Davidsons Plum	*Davidsonia pruriens* subsp *jerseyana*
Queensland Blossom Bat	*Syconycteris australis*	Hairy Quandong	*Elaeocarpus williamsianus*
Little Bent-wing Bat	*Miniopterus australis*	Crystal Creek Walnut	*Endiandra floydii*
Wompoo Fruit-dove	*Ptilinopus magnificus*	Green-leaved Rose Walnut	*Endiandra muelleri* sub sp *bracteata*
Osprey	*Pandion haliaetus*	Queensland Nut	*Macadamia tetraphylla*
Eastern Long-eared Bat	*Nyctophilus bifax*	Spiny Gardenia	*Randia moorei*
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Red Lilly Pilly	*Syzygium hodkinsoniae*
Bush-hen	*Amaurornis olivaceus*	Coolamon Tree	*Syzygium moorei*
Pied Oystercatcher	*Haematopus longirostris*		
Sooty Oystercatcher	*Haematopus fuliginosus*		
Rose-crowned Fruit-dove	*Ptilinopus regina*		
Superb Fruit-dove	*Ptilinopus superbus*		
Collared Kingfisher	*Todiramphus chloris*		
Mangrove Honeyeater	*Lichenostomus fasciogularis*		

1.9 Threatened Species Considered Not Relevant

A range of additional threatened species are known to occur in the locality, at least on occasion, on the basis of previous fauna investigations and various flora and fauna databases from the general vicinity (Tables 2 & 3). These species are generally either not regarded as likely to occur along the proposal (*ie* within the areas which are to be disturbed by the proposed roadworks - the "*study area*") or are not considered likely to be affected by the proposed roadworks even if they do occur in the vicinity, given their mobility, resource requirements and/or habits.

The species listed in Tables 2 and 3, and their habitat requirements, have been considered in the process of selecting the preferred route and in the implementation of design, engineering and impact amelioration measures for the proposal. These approaches are intended specifically to avoid imposing adverse impacts on these threatened species and their habitats, thus avoiding the potential for imposing "*a significant effect*" on them.

1.9.1 Threatened Fauna Species

A range of additional threatened fauna species are known from the general area (Table 2), but none were recorded during fauna investigations conducted for the proposal. These

species have been eliminated from the list of relevant species on the basis of the lack of suitable resources or habitats, their absence from relevant habitats along the proposed alignment, the imposition of existing impacts (*eg* the newly constructed Brunswick Heads Bypass, the existing Pacific Highway, previous clearing and/or development), and/or on the basis of their habits.

Table 2 Threatened fauna species recorded in the locality or the general area (but not recorded in the study area for this project), and additional species listed on the NSW NP&WS Director General's requirements for the SIS. Species are grouped according to habitat preferences. Threatened fauna species considered further in this s.5A Assessment (Table1) are not included.

WOODLAND/FOREST	RAINFOREST
Square-tailed Kite	Barred Cuckoo-shrike
Red Goshawk	White-eared Monarch
Bush Stone Curlew (Bush Thick-knee)	Olive Whistler
Swift Parrot	Double-eyed Fig Parrot (Coxen's Fig Parrot)
Red-tailed Black Cockatoo	Sooty Owl
Painted Honeyeater	Marbled Frogmouth
Regent Honeyeater	Albert's Lyrebird
Masked Owl	Black Flying-Fox
Powerful Owl	Golden-tipped Bat
Common Planigale	Pouched Frog
Brush-tailed Phascogale	Stephen's Banded Snake
Long-nosed Potoroo	Pale-headed Snake
Yellow-bellied Sheathtail Bat	
Eastern Freetail-bat (Little Mastiff Bat)	
Large Bent-wing Bat (Common Bent-wing Bat)	
Hoary Bat	
Large Pied Bat	
Tiger Quoll	
White-crowned Snake	
WETLAND/SWAMP	**COASTAL/PELAGIC**
Freckled Duck	Wandering Albatross
Magpie Goose	Red-tailed Tropicbird
Black-necked Stork	Gould's Petrel
Brolga	Black-winged Petrel
Comb-crested Jacana	Flesh-footed Shearwater
Large-footed Myotis (Fishing Bat)	Great Knot
Green-thighed Frog	Little Tern
Green & Golden Bell Frog	Beach Stone-curlew
Wallum Tree Frog (Wallum Sedge-frog)	Sanderling
Wallum Froglet	Greater Sandpiper
	Terek Sandpiper
	Lesser Sandpiper
RIPARIAN	**GRASSLAND**
Black Bittern	Eastern Grass Owl
Australasian Bittern	
Gold-eyed Barred Frog	

In this respect:

- coastal and pelagic species (*eg* the Little Tern, albatrosses, marine mammals) are not expected to occur along the alignment, given the absence of suitable habitat for these species;
- species dependent on wetland and swamp habitats (*eg* the Comb-crested Jacana, Wallum Froglet, Wallum Sedge-frog and Green & Golden Bell Frog) will not be affected, given that no significant clearing of suitable wetland habitats is required and given the implementation of measures to avoid adverse impacts on wetlands in the general vicinity of the alignment;

- no adverse impacts on either the Black-necked Stork or Brolga are likely, given both species' rarity in the general area and the lack of suitable or significant habitat;
- the Black and Australasian Bitterns are not expected to be adversely affected by the proposal, even if they occur in the locality, because of a scarcity of suitable habitat, and because impacts at sites which are of potential value (*eg* Marshall's Creek) are to be confined substantially to areas already affected by the Pacific Highway. No undisturbed or unmodified habitat for these species is present, and there is no likelihood of any "*significant effect*" being imposed on them, even if they are present (see s.5A Assessment for the Bush-hen); and
- the additional woodland and forest species (Table 2) are not considered relevant on the basis of the relatively small areas of potential habitat to be removed, the existing levels of disturbance in the locality and their mobility. Species of relevance in this regard include the Regent Honeyeater, Black Flying-fox, Sooty Owl and Glossy Black Cockatoo.

Whilst a number of threatened fauna and flora species additional to those considered above (Section 1.8) have been recorded during previous investigations in the general vicinity of the proposal (within approximately 1km), the lack of records for these species despite intensive and targeted surveys, and the extent of disturbance along the proposal alignment (Route A2 and the Brunswick Heads Bypass duplication), as well as the disturbed and modified nature of most of the areas to be affected, suggests that whilst a "*significant effect*" is possible, it is not "*likely*". In this regard:

- no evidence for the Long-nosed Potoroo was obtained from either the duplication study area or the Route A2 study area, despite extensive and appropriate field investigations;
- there are no records of the Common Planigale from either the duplication or Route A2 study areas, nor was this species recorded by Milledge & McKinley (1992). There is no record of the Common Planigale from the study area, and its ability to utilise a range of habitats and environments suggests that the imposition of "*a significant effect*" is not "*likely*";
- no evidence for the Eastern Grass Owl was obtained from the study areas, despite dedicated and appropriate survey methods. This species is not likely to utilise the Bypass duplication study area, and potential habitat occurs close to, but not along, Route A2; and
- no threatened amphibian species were recorded from the proposal study areas, despite investigations under appropriate and suitable conditions. Furthermore, those areas of potentially suitable habitat which are to be affected along the proposal are limited and generally modified or disturbed.

On the basis of the above considerations, there is no likelihood of any "*significant effect*", being imposed on these additional species of conservation concern known from the locality or regarded as potentially occurring.

Furthermore, the proposal has been specifically located and designed to minimise the potential for adverse impacts to be imposed upon any threatened biota or their habitats at this location. Measures are incorporated into the design of the project and will be implemented as part of its construction to avoid affecting these species. Consequently, these species have not been considered individually in the s.5A Assessments of Significance with respect to the proposed Pacific Highway project at Brunswick Heads.

1.9.2 Threatened Flora Species

Several additional threatened flora species have also previously been recorded within 10km of the proposal or were listed by the NP&WS as species to be considered in the Species Impact Statement (SIS) for the proposal (Table 3). However, none of these additional species (extra to those listed in Table 1) were recorded along Route A2 during the extensive and detailed field investigations which have been conducted along the alignment and in the vicinity.

Table 3 Threatened flora species recorded within 10km of the proposal and/or included on the NP&WS Director-General's requirements for the SIS.

Scientific Name	Habitat	A	B
Acronychia littoralis	Littoral rainforest on sand	No	Limited
Bosistoa selwynii	Rainforest below 300m altitude	No	Limited
Bosistoa transversa	Rainforest to an altitude 150m	No	Limited
Choricarpia subargentea	Regrowth in dry rainforest	No	Marginal
Corokia whiteana	Warm temperate rainforest on poorer soils	No	Limited
Davidsonia sp *A*	Disturbed subtropical rainforest or on the margins of sclerophyll forest	No	Yes
Diploglottis campbellii	Riverine rainforest	No	No
Endiandra hayesii	Lowland subtropical rainforest on sedimentary soils and alluvium in cool, moist, sheltered valleys	No	Marginal
Floydia praelta	Subtropical and riverine rainforest	No	Limited
Hicksbeachia pinnatifolia	Subtropical rainforest	No	Limited
Ochrosia moorei	Subtropical rainforest	No	Limited
Persicaria elatior	Damp places	No	Limited
Phaius australis	*Melaleuca quinquenervia* swamps and in sclerophyll forest, on the coast, at or near sea level	No	Yes
Tinospora tinosporoides	Wetter subtropical rainforest	No	Marginal

A Recorded during the intensive and dedicated field investigations along the proposed Pacific Highway upgrade at Brunswick Heads ?
B Is suitable habitat present along the proposal ?

In addition to the lack of records for any of these additional species along the proposed alignment, the disturbed and modified nature of the environment through which Route A2 is to be located (at least in the majority) limits the likelihood of "*a significant effect*" being imposed on these species. Specific surveys for several of the orchid species and for *Acronychia littoralis* (LES 1994) along the Brunswick Heads Bypass indicate that none of the endangered orchid species are present, and that the known stand of *Acronychia littoralis* was to be avoided. Similarly, none of these species were recorded either along the Bypass duplication nor on Route A2 during investigations for this report.

Given the approach to the proposal, which has included extensive consideration of environmental matters, particularly associated with biota and their habitats, and given the approaches to minimising the potential for adverse impacts from the proposal, including the clearing of native vegetation, these additional species are not considered of relevance for the assessment of potential impacts under s.5A of the EP&A Act.

It is not likely that the proposal will involve the imposition of any "*significant effect*" on these additional flora species, given the lack of evidence of their presence within the area to be affected by the proposal, despite intensive field investigations. Consequently, they have not been considered in the s.5A Assessments of Significance with respect to the proposed Pacific Highway upgrade at Brunswick Heads.

2 APPROACH

Notwithstanding the considerations in Section 1 regarding the difficulties of defining "*a viable local population*" for many of the species which do or may occur along Route A2, and difficulties with regard to determining whether the proposal will involve the imposition of "*a significant effect*" on any species, the approach which has been adopted to consideration of s.5A of the EP&A Act and to the design of the proposal has been 'conservative'. In this regard, where a threatened plant or animal species has been recorded along Route A2 or in the immediate vicinity, even if represented by only a single individual, it has been assumed that "*a viable local population*" maybe present in the general vicinity. Similarly, where a threatened species is regarded as likely to occur on occasions along Route A2, and would be likely to be affected to a significant or notable extent by the proposal, consideration under s.5A of the EP&A Act has proceeded on the basis that "*a viable local population*" could be present.

In addition to adopting a 'conservative' approach to the consideration of individual species under s.5A of the EP&A Act, the proposal has generally adopted the Precautionary Principle, which states that:

> "*Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environment degradation*".

As documented in the EIS and in the Flora & Fauna Assessment Report to which this s.5A Assessment of Significance is appended, the approach to the proposal has generally been to incorporate environmentally sensitive design concepts, to avoid the potential for imposing "*serious or irreversible environmental damage*". The intention is for the proposal to be constructed and maintained in an environmentally sensitive manner, to minimise environmental disturbance or degradation, and to avoid the imposition of significant impacts upon native biota in general and on threatened fauna and flora in particular.

Furthermore, both the proposal in general and the consideration of threatened biota in particular have adopted the Precautionary Principle as a basic element in the assessment of impacts and in the design and construction protocols to be implemented as part of the proposal. Thus, a range of impact amelioration measures are incorporated into the proposal (including minimal clearing of native vegetation, protection of plants to be retained, propagation of threatened species which must be removed, road design to minimise the footprint of the proposal *etc*) which specifically involve the implementation of "*measures to prevent environmental degradation*". On this basis, both the proposal in general and the consideration of threatened biota in this s.5A Assessment of Significance have incorporated the Precautionary Principle.

In addition to including measures in the design and construction processes for the proposal to avoid or ameliorate potential impacts being imposed upon native biota and their habitats, the proposal includes the preparation of an Environmental Management Plan (EMP) for the construction phase and subsequent maintenance of the road and associated structures. Relevant elements of the EMP will include management of stormwater discharge ponds and other water quality control structures, maintenance of landscaping and the rehabilitation of native vegetation along the alignment, the propagation of threatened plant species which must be removed from Route A2 and their use in replanting and rehabilitation landscaping, and the provision of compensatory habitat (to replace areas of native vegetation which must be disturbed for the proposal). These features of the proposal contribute to achieving the goals of the Precautionary Principle, and to ensuring an environmentally sensitive development.

The EMP will also involve the design and implementation of a monitoring program for the proposal, particularly associated with ensuring that stormwater discharges are appropriately managed, that no significant impact is being imposed upon wetlands and aquatic or swamp habitats, and that fauna underpasses are functioning appropriately.

3 FACTORS for CONSIDERATION

An individual s.5A Assessment of Significance has been prepared for each of the threatened species regarded as of potential relevance for the proposed duplication of the Brunswick Heads Bypass and upgrade of the Pacific Highway, Brunswick to Yelgun. Relevant threatened species include those species known to occur along Route A2 or which could possibly be affected by the proposal (Section 1.8).

3.1 Threatened Flora Species

Nine threatened flora species are regarded as of relevance to consideration of the potential for "*a significant effect*" to arise from the proposal (Table 4). These 9 species represent the only threatened plants which were actually recorded from Route A2 or its vicinity, and individuals of only six of these species will require removal for the construction of the proposal.

Table 4 State-wide conservation status of the threatened flora species considered of relevance to the proposed highway upgrade at Brunswick Heads.

SPECIES NAME	COMMON NAME	STATUS
Cryptocarya foetida	Stinking Cryptocarya	V
Davidsonia pruriens subsp *jerseyana*	Davidson's Plum	E
Elaeocarpus williamsianus	Hairy Quandong	E
Endiandra floydii	Crystal Creek Walnut	E
Endiandra muelleri subsp *bracteata*	Green-leaved Rose Walnut	E
Macadamia tetraphylla	Queensland Nut	V
Randia moorei	Spiny Gardenia	E
Syzygium hodgkinsoniae	Red Lilly Pilly	V
Syzygium moorei	Coolamon Tree	V

E Endangered - Schedule 1 of the TSC Act
V Vulnerable - Schedule 2 of the TSC Act

It should be noted that the field investigations for flora along Route A2 have been intensive and comprehensive, and it is not considered likely that additional threatened flora species are present. It should also be noted that other individuals of all of the species considered below are present outside the Route A2 alignment, and the proposal does not involve the removal of all individuals of any of these species.

3.1.1	Davidson's Plum	*Davidsonia pruriens* subsp *jerseyana*	Endangered (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

Davidson's Plum is a slender tree to 10m which occurs in subtropical rainforest on acidic red or neutral yellow podzolic soils over a range of parent materials, generally occurring at altitudes less than 300m. It is endemic to the North Coast region of NSW in the vicinity of the Brunswick and Tweed Rivers (WBM Oceanics 1996; Quinn *et al* 1995).

Davidson's Plum is listed as an Endangered species under Schedule 1 of the TSC Act and as an Endangered species on Part 1 of the ESP Act. It has a ROTAP code of 2ECi (Briggs & Leigh 1996), indicating that the species has a national geographic range of less than 100km, with less than 1000 plants known to occur within a conservation reserve (Briggs & Leigh 1996).

This species is sporadically distributed within the Brunswick Heads area, with the total population being estimated at approximately 1000 to 1500 plants (Quinn *et al* 1995). During field surveys conducted for proposal, individuals or small groups of this species were recorded in regrowth Brush Box *Lophostemon confertus* forest and rainforest at three locations near Route A2:

- south-facing slopes between the Brunswick River and Banana Rd;
- west of the Salad Bowl Caravan Park; and
- regrowth forest alongside the railway line at the northern end of the study area.

Up to 25 individuals of Davidson's Plum will be removed between the Brunswick River and Banana Road, but there are substantial numbers of other individuals in this locality. Specimens of Davidson's Plum near the Salad Bowl Caravan Park and in regrowth forest along the railway line near Yelgun do not appear likely to be removed. Additionally, there are substantial populations of Davidson's Plum elsewhere in the locality, such as at Hilans Corner and in rainforest along the Brunswick River, to the west of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of Davidson's Plum has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

Davidson's Plum occurs only in the NSW North Coast region and is confined to the Tweed Heads area, in the vicinity of the Mt Warning caldera. Up to 1500 individuals occur in the Brunswick Heads area, of which approximately 25 individuals will potentially be affected by the proposal. As only a relatively small number of individuals and of potential habitat (perhaps 2ha) will require removal, the "*area of known habitat to be modified or removed*" is not regarded as "*significant*" in terms of its "*regional distribution*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The Route A2 alignment (Brunswick to Yelgun) will require the removal of some individuals of Davidson's Plum on south-facing slopes between the Brunswick River Bridge and Banana Road. The removal of this small section of habitat will cause minor fragmentation of the existing ribbon of vegetation extending along the alignment edge, and connecting the Brunswick Heads NR with vegetation stands further north.

Davidson's Plum has a large fleshy fruit, and it is possible that seeds are dispersed by large birds or fruit bats. On this basis, the removal of a small stand of vegetation would not necessarily result in the isolation of the stands of Davidson's Plum in the Brunswick Heads NR from the stands to the north of Banana Road.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for Davidson's Plum. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), populations of the Davidson's Plum are reserved in three Nature Reserves (Table 5). However, information regarding reserved population sizes is currently insufficient to determine the adequacy of representation in these reserves.

Notwithstanding these records, the Davidson's Plum is classified as Endangered under the TSC Act, and therefore does not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 5 The extent of reservation of the Davidson's Plum *Davidsonia pruriens* subsp *jersayana* in the NSW North Coast region (Quinn *et al* 1995; Sheringham & Westaway 1995; Briggs & Leigh 1996; WBM Oceanics 1996; A Benwell *unpubl data*).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
Nature Reserves		
Brunswick Heads NR	1km N of Brunswick Heads	<1000 plants reserved
Billinudgel NR	10km N of Brunswick Heads	not accurately known
Inner Pocket NR	~ 11.5km NW of Brunswick Heads	not accurately known

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation

by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for Davidson's Plum could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

Davidson's Plum is endemic to the North Coast of NSW in the vicinity of the Tweed and Brunswick Rivers. This species reaches the southern limit of its "*known distribution*" within the study area (Brunswick Heads NR - Sheringham & Westaway 1995).

CONCLUSIONS

The eight factors which are required to be considered under s.5A of the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Davidson's Plum, are discussed in detail above.

The proposed upgrade of the Pacific Highway, Brunswick to Yelgun will require the removal of up to forty-five Davidson's Plum at several sites along Route A2. Whilst this may not constitute a significant element of the species' population in the locality, it does involve the removal of stands of Davidson's Plum. As a consequence, the proposal has the potential to involve the imposition of "*a significant effect*" on this species at these localities.

A Species Impact Statement is required for the activity with respect to the Davidson's Plum.

3.1.2 Queensland Nut *Macadamia tetraphylla*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Queensland Nut *Macadamia tetraphylla* is a small to medium tree to 15m in height, which is often multi-trunked close to the base. This species occurs in lowland subtropical rainforest and notophyll vine forest at altitudes of approximately 150m. It flowers from August to October, and bears ripe fruit in January (Harden 1991).

The Queensland Nut is listed as a Vulnerable species under Schedule 2 of the TSC Act (NSW), and as Vulnerable on Schedule 2 of the ESP Act (Cth).The Queensland Nut has a ROTAP code of 2VC- (Briggs & Leigh 1996), indicating that the species has a national geographic range of less than 100km. It is described as Vulnerable, with the current reserved population size not accurately known.

The Queensland Nut is endemic to the eastern margin of the Mt Warning shield, occurring between Rous near Lismore in northern NSW and Mt Tamborine in southeastern Queensland. It is known from numerous locations within its distributional range, and appears to be relatively well-represented in conservation reserves in the NSW North Coast region (see below).

One adult tree was recorded in regrowth rainforest on the western side of the sewage treatment plant access road during the field investigations conducted for this report. The tree is located approximately 120m west of Route A2, and therefore will not be affected by

the proposal.

Given the absence of "*a viable local population*" of the Queensland Nut along the proposed road corridor, this species will not be "*placed at risk of extinction*" as a result of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Queensland Nut has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

The distribution of Queensland Nut occurs in coastal areas north of the Clarence River, chiefly in the Richmond and Tweed valleys (WBM Oceanics 1996). As only a single individual of Queensland Nut was recorded on the western side of the sewage treatment plant access road, which is 120m from the proposed upgrade of the Pacific Highway, there will be no "*known habitat modified or removed*", although some potential habitat will be affected.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The only area of "*known habitat*" for the Queensland Nut in the general study area occurs approximately 120m to the west of Route A2 and will not require removal as a result of the proposal. This site is already isolated from other areas of potential habitat in the locality by cleared lands, and the proposal will not contribute further to that isolation. Furthermore, potential propagators and pollinators of the Queensland Nut will not be prevented by the proposal from visiting this tree or other individuals in the wider surrounding area.

Given that the proposed road corridor will avoid the only known specimen of the Queensland Nut in the study area, it is not likely that "*an area of known habitat*" for this species "*is likely to become isolated from currently interconnecting or proximate areas of habitat*" as a result of the proposal.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Queensland Nut. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), populations of the Queensland Nut are reserved in two National Parks, four Nature Reserves, and two Flora Reserves (Table 6). However, populations at any given location tend to be small (often <10-20 - P Pisanu University of New England *pers comm*).

Furthermore, notwithstanding these reserved populations, the Queensland Nut is classified as Vulnerable under the TSC Act, and therefore does not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 6 The extent of reservation of the Queensland Nut *Macadamia tetraphylla* in the NSW North Coast region (Quinn *et al* 1995; Briggs & Leigh 1996).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
National Parks		
Nightcap NP	30km N of Lismore	not accurately known
Mt Warning	10km SW of Murwillumbah	<1000 plants reserved
Nature Reserves		
Davis Scrub NR	35km E of Casino	<1000 plants reserved
Limpinwood NR	20km W of Murwillumbah	<1000 plants reserved
Numinbah NR	17km NW of Murwillumbah	<1000 plants reserved
Victoria Park NR	35km E of Casino	<1000 plants reserved
Flora Reserves		
Minyon Falls FR	22km SW of Brunswick Heads	not accurately known

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for the Queensland Nut could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Queensland Nut is endemic to the eastern margin of the Mt Warning shield between Rous near Lismore and Mt Tamborine in Queensland, occurring in coastal areas north of the Clarence River, chiefly in the Richmond and Tweed Valleys (WBM Oceanics 1996).

Route A2 is located within the "*known distribution*" of the Queensland Nut, with records from well to the north, south and west of the study area (Quinn *et al* 1995). Consequently, this species cannot be considered to occur "*at the limit of its known distribution*" along the proposed road corridor nor in the study area.

CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Queensland Nut, are discussed in detail above.

The only "*known habitat*" of the Queensland Nut in the study area is located approximately 120m west of the proposed proposed road corridor. As a consequence, the project will not involve the imposition of "*a significant effect*" on the Queensland Nut.

A Species Impact Statement is not required for the activity with respect to the Queensland Nut.

3.1.3 Crystal Creek Walnut	*Endiandra floydii*	Endangered (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Crystal Creek Walnut is a small rainforest tree endemic to the Tweed and Brunswick Valleys (Harden 1990). It occurs in rainforest on soils derived from metasediment often on steep slopes. This species occurs in Brush Box forest and rainforest in the lower Brunswick Valley from the mouth of the Brunswick River inland to Mt Chincogan near Mullumbimby (A Benwell *unpubl data*).

The Crystal Creek Walnut is listed as an Endangered species under Schedule 1 of the TSC Act and as an Endangered species on Part 1 of the ESP Act (Cth). It has a ROTAP code of 2VC- (Briggs & Leigh 1996), indicating that the species has a national geographic range of less than 100km. It is described as Vulnerable, with the current reserved population size not accurately known.

The total population of the Crystal Creek Walnut in the Brunswick Heads area is estimated to be approximately between 300 to 500 mature trees (A Benwell *pers comm*), with the largest populations occurring in Brunswick Heads NR and the Hilans Corner area.

The Crystal Creek Walnut was recorded in Brush Box forest and rainforest at four locations during field investigations in the study area:

- properties in Oola place backing onto the existing Highway;
- regrowth forest immediately west of Brunswick Heads NR;
- steep slopes below Banana Rd; and
- rainforest west of the Salad Bowl Caravan Park.

Of the plants recorded, a total of five mature trees and two juveniles which occur on or adjacent to Route A2 at Oola place and on steep slopes along Banana Road will require removal as a result of the proposal. Plants immediately west of Brunswick Heads NR are approximately 100m west of the proposed road corridor and will not be affected. Individuals west of the Salad Bowl Caravan Park are also located well outside Route A2.

Approximately 7 individuals of *E floydii* appear likely to be removed for the proposal.

Whether this group of plants represents a "*local viable population*" is not clear (see Section 1), but the species is not (if this group represents a viable population) likely to be placed "*at risk of extinction*" in the locality. Nevertheless, this individual "*local population*" may be "*at risk of extinction*" as a result of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Crystal Creek Walnut has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

The distribution of Crystal Creek Walnut is confined to the Tweed district on the North Coast of NSW. A total of five mature trees and two juveniles were recorded within the A2 alignment, and will require removal. However, substantial areas of habitat supporting specimens of this species occur elsewhere in the locality, and it appears that the area of known habitat "*to be modified or removed*" is not significant.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The proposal will require the removal of Crystal Creek Walnut from properties in Oola Place backing onto the existing highway, the Brunswick Heads NR and the steep slopes below Banana Road. The removal of a small section of habitat will cause minor fragmentation of the existing vegetation extending along the proposed upgrade of the Pacific Highway, Brunswick to Yelgun. However, Route A2 was selected in part because it created the least habitat fragmentation of all of the proposed route options.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Crystal Creek Walnut. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), the Crystal Creek Walnut is reserved in Brunswick Heads NR, immediately north of the Brunswick River although the size of the reserved population at this locality is not accurately known. This species is also considered likely to occur in Numinbah NR in the Tweed Valley, given its known distribution and the habitats present (A Benwell *pers comm*).

Given that the Crystal Creek Walnut is known from only one conservation reserve (Table 7), and on the basis of its classification as an Endangered species under the TSC Act, this

species would not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 7 The extent of reservation of the Crystal Creek Walnut *Endiandra floydii* in the NSW North Coast region (Sheringham & Westaway 1995; Briggs & Leigh 1996).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
Nature Reserves		
Brunswick Heads NR	1km N of Brunswick Heads	not accurately known
Numinbah NR	17km NW of Murwillumbah	not accurately known

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for Crystal Creek Walnut could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

Crystal Creek Walnut is endemic to the Tweed and Brunswick Valleys in the North Coast region of NSW. This species reaches the southern limit of its "*known distribution*" within the study area (Brunswick Heads NR - Sheringham & Westaway 1995).

Conclusions

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Crystal Creek Walnut, are discussed in detail above.

The proposed upgrade of the Pacific Highway, Brunswick to Yelgun, will require the removal of seven Crystal Creek Walnut trees at two locations along Route A2. As a consequence, the proposal has the potential to involve the imposition of "*a significant effect*" on the Crystal Creek Walnut at these localities.

A Species Impact Statement is required for the activity with respect to the Crystal Creek Walnut.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Hairy Quandong *Elaeocarpus williamsianus* is a small rainforest tree to 15m in height that is occasionally multi-stemmed from ground level. This species favours medium fertility soils formed on metasediment. It occurs in Brush Box *Lophostemon confertus* forest and rainforest.

The Hairy Quandong is listed as an Endangered species under Schedule 1 of the TSC Act and as an Endangered species on Part 1 of the ESP Act (Cth). It has a ROTAP code of 2ECi (Briggs & Leigh 1996), indicating that the species has a national geographic range of less than 100km. It is described as Endangered, with less than 1000 plants known to occur in conservation reserves (Briggs & Leigh 1996).

This species is known from only six locations in lowland rainforest in the Brunswick and Tweed Valleys: Mill Road, Goonengerry; Banana Road, Ocean Shores; Inner Pocket NR; Upper Burringbar; Mooball SF; and Couchy Creek, Tweed Valley). The total known population in NSW is estimated to be less than 300 trees (Quinn *et al* 1995).

During flora surveys in the study area, a group of approximately 15 Hairy Quandongs were recorded below Banana Road in Brush Box forest on a lower slope near the edge of cleared land. This population is approximately 110m to the west of the Route A2 alignment (including batters). An additional tree was located 100m upslope to the east of the larger population, approximately 50m from Route A2. The proposal is not likely to have an adverse impact on any of these trees, given their distance from the proposed road corridor.

Given the absence of any evidence for a "*viable local population*" of the Hairy Quandong along the proposed road corridor, this species is not "*likely to be placed at risk of extinction*" as a result of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Hairy Quandong has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

As noted in the introduction, the A2 alignment is located in the NSW North Coast region, as defined in the TSC Act. No "*known habitat*", and little potential habitat for the Hairy Quandong is to be "*modified or removed*" for the proposal.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The proposed upgrade of the Pacific Highway, Brunswick to Yelgun, will not require the removal of any individuals of Hairy Quandong. The stand and the one individual located below Banana Road in Brush Box (*Lophostemon confertus*) forest on a lower slope near the edge of cleared land are beyond the Route A2 alignment, and will not be affected by the proposal.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Hairy Quandong. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), the Hairy Quandong is only reserved in Inner Pocket NR, located approximately 11.5km northwest of Brunswick Heads. The size of the reserved population at this locality is not accurately known. However, the total population of this species in NSW is estimated to be less than 300 individuals (Quinn *et al* 1995).

Given that the Hairy Quandong is known from only one conservation reserve, and on the basis of its classification as an Endangered species under the TSC Act, this species would not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for the Hairy Quandong could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Hairy Quandong is endemic to lowland forest in the Brunswick and Tweed Valleys where it is known from only six locations, including the population along Banana Road within the study area. Of the other five known localities, four are to the north and northwest of the study area (Couchy Creek, Mooball SF, Upper Burringbar, and Inner Pocket NR), and one to the southwest (Mill Road, Goonengerry).

Given the occurrence of Hairy Quandong to the north, northwest and southwest of the study area, this species can not be considered to occur at the "*limit of its known distribution*" in the study area.

CONCLUSION

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Hairy Quandong, are discussed in detail above.

Route A2 avoids the areas of "*known habitat*" of the Hairy Quandong in the general vicinity, and no individuals are to be affected. As a consequence, the proposal will not involve the imposition of "*a significant effect*" on this species.

A Species Impact Statement is not required for the activity with respect to the Hairy Quandong.

3.1.5 Coolamon Tree	*Syzygium moorei*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Coolamon Tree *Syzygium moorei* is a medium-sized tree which occurs in lowland subtropical rainforest on basaltic alluvium soils. It is restricted to the Richmond, Brunswick and Tweed River systems of NSW, and is endemic to the eastern margin of the Mt Warning shield. Populations are represented in a number of conservation reserves in the North Coast region (see below).

It is listed as a Vulnerable species under the TSC Act (NSW), and is listed as Vulnerable under the ESP Act (Cth).The Coolamon Tree has a ROTAP code of 2VCi (Briggs & Leigh 1996), indicating that the species has a national geographic range of less than 100km. It is described as Vulnerable, with less than 1000 plants known to occur in conservation reserves (Briggs & Leigh 1996).

This species was recorded at three locations within the study area:

- west of the existing Highway within Brunswick Heads NR;
- east of the existing Highway within Brunswick Heads NR; and
- rainforest west of the Salad Bowl Caravan Park.

All of the individuals recorded at these localities were outside the proposed road corridor.

Given the absence of any individuals along Route A2, there is no likelihood of a "*viable local population*" of the Coolamon Tree being "*placed at risk of extinction*" as a result of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Coolamon Tree has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

The distribution of Coolamon Tree is restricted to the eastern margin of the Mt Warning shield and to the Richmond, Brunswick and Tweed River systems of NSW. No individuals of this species are to be affected by the proposal, and it appears that no "*known habitat*" is to be removed.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The proposal will avoid all known specimens and stands of the Coolamon Tree in the study area. Thus, whilst it is possible that some potential habitat for this species will require removal for the proposal, "*known habitat*" for this species will not "*become isolated from interconnecting or proximate areas of habitat*". Indeed, if roads were to constitute a barrier for this species, the existing Pacific Highway would already fulfil that function.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Coolamon Tree. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), populations of the Coolamon Tree are reserved in four nature reserves (Table 8). However, information regarding reserved population size is currently insufficient to determine the adequacy of representation in such reserves.

Notwithstanding these records, the Coolamon Tree is classified as Vulnerable under the TSC Act, and therefore does not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 8 The extent of reservation of the Coolamon Tree *Syzygium moorei* in the NSW North Coast region (Sheringham & Westaway 1995; Briggs & Leigh 1996).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
Nature Reserves		
Brunswick Heads NR	1km N of Brunswick Heads	<1000 plants reserved
Numbinah NR	17km NW of Murwillumbah	not accurately known
Hayters Hill NR	5km SW of Byron Bay	not accurately known
Stotts Island NR	12km NE of Murwillumbah	<1000 plants reserved

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for the Coolamon Tree could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Coolamon Tree is endemic to the Tweed, Richmond and Brunswick Valleys in the North Coast region of NSW. This species is noted to be at the southern "*limit of its known distribution*" within the study area (Brunswick Heads NR - Sheringham & Westaway 1995), although it has been recorded between Alstonville and Ballina (Sheringham & Westaway 1995) and at Hayters Hill NR to the southwest.

CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Coolamon Tree, are discussed in detail above.

Route A2 avoids the areas of "*known habitat*" of the Coolamon Tree recorded in the study area. As a consequence, the proposal will not involve the imposition of "*a significant effect*" on this species.

A Species Impact Statement is not required for the activity with respect to the Coolamon Tree.

3.1.6 Red Lilly Pilly	*Syzygium hodgkinsoniae*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

Red Lilly Pilly is a small rainforest tree with smooth fibrous to flaky bark. It occurs on basaltic soil, alluvium and metasediment derived soils in Brush Box forest and rainforest up to an altitude of about 500m (A Benwell *unpubl data*).

The Red Lilly Pilly has a ROTAP code of 3VC- (Briggs & Leigh 1996), indicating that the species has a national geographic range of over 100km. It is described as Vulnerable, with the current reserved population size not accurately known (Briggs & Leigh 1996). The Red Lilly Pilly is listed as a Vulnerable species under Schedule 2 of the TSC Act (NSW), and is listed as Vulnerable on the ESP Act (Cth).

This species is distributed from the Richmond River in northern NSW to Kin Kin in southeast Queensland. It was recorded at three locations within the study area during

investigations for this report:

- west of the existing Highway within Brunswick Heads NR;
- east of the existing Highway within Brunswick Heads NR; and
- along Old Stock Route Road.

Of the plants recorded, two individuals (one adult and one juvenile) along Old Stock Route Road are located along Route A2 and will require removal. Plants recorded in the Brunswick Heads NR east and west of the existing Highway are located well outside the proposed road corridor.

It is unlikely that "*a viable local population*" of this species "*is likely to be placed at risk of extinction*", given that only a few individuals will be affected by the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Red Lilly Pilly has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). Red Lilly Pilly occurs in Lismore, Alstonville, Nullum, Mt Warning and much of Tweed Valley, with a geographic range of over 100km (Briggs Leigh 1996).

As noted above, only two individuals of the Red Lilly Pilly are to be removed for the proposal. In terms of "*the regional distribution of the habitat*" for this species, the "*area of known habitat*" for the Red Lilly Pilly which is to be "*modified or removed*" is not regarded as of significance or consequence in terms of the species' conservation.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The proposal will require the removal of two specimens of Red Lilly Pilly from the study area. Whilst a small area of habitat for this species will require removal for the proposal, "*known habitat*" for this species will not "*become isolated from interconnecting or proximate areas of habitat*". Indeed, if roads were to constitute a barrier for this species, the existing Pacific Highway would already fulfil that function.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Red Lilly Pilly. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), populations of the Red Lilly Pilly are reserved in two National Parks, ten Nature Reserves, and two Flora Reserves (Table 7). While comprehensive population data are not available for the species, at least 1000 plants are also estimated to occur in Nullum and Mooball SFs (*unpublished data* NP&WS CRA).

Notwithstanding these populations, the Red Lilly Pilly is classified as Vulnerable under the TSC Act, and therefore does not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 9 The extent of reservation of the Red Lilly Pilly *Syzygium hodgkinsoniae* in the NSW North Coast region (Sheringham & Westaway 1995; Briggs & Leigh 1996).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
National Parks		
Nightcap NP	30km N of Lismore	not accurately known
Mt Warning	10km SW of Murwillumbah	not accurately known
Nature Reserves		
Brunswick Heads NR	1km N of Brunswick Heads	<1000 plants reserved
Boatharbour NR	~ 8km NE of Lismore	not accurately known
Davis Scrub NR	~ 5.5km SW of Alstonville	not accurately known
Big Scrub NR	24km SW of Brunswick Heads	<1000 plants reserved
Snows Gully NR	~ 16.5km SW of Byron Bay	not accurately known
Limpinwood NR	20km W of Murwillumbah	<1000 plants reserved
Numinbah NR	17km NW of Murwillumbah	<1000 plants reserved
Johnstones Scrub NR	9km W of Bangalow	not accurately known
Hayters Hill NR	5km SW of Byron Bay	not accurately known
Inner Pocket NR	~ 11.5km NW of Brunswick Heads	not accurately known
Flora Reserves		
Boomerang Falls FLR	22km WSW of Brunswick Heads	not accurately known
Minyon Falls FLR	22km SW of Brunswick Heads	not accurately known

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for the Red Lilly Pilly could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Red Lilly Pilly is widespread but uncommon from the Richmond River area of NSW to Kin Kin in southeast Queensland. Route A2 is encompassed within the "*known distribution*" of this species, with records from the north, south and southwest of the study area (Sheringham & Westaway 1995).

Consequently, the Red Lilly Pilly cannot be considered to occur *"at the limit of its known distribution"* along the proposed road corridor nor in the study area.

CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Red Lilly Pilly, are discussed in detail above.

The proposed upgrade of the Pacific Highway, Brunswick to Yelgun, will require the removal of two Red Lilly Pilly trees located along Route A2. Nevertheless, given its distribution and presence in reserves in the locality, it is not likely that the proposal will involve the imposition of "*a significant effect*" on this species at this locality.

A Species Impact Statement is not required for the activity with respect to the Red Lilly Pilly.

3.1.7 Green-Leaved Rose Walnut *Endiandra muelleri* subsp *bracteata*
Endangered (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Green-Leaved Rose Walnut is a buttressed tree to 30m, that inhabits lowland Brush Box forest and rainforest on medium fertility soils or metasediment. This species' distribution is poorly known, partly because of confusion with its identification. It is found north from Maclean in NSW, but occurs mainly on the eastern margin on the Mt Warning shield.

The Green-leaved Rose Walnut is listed as an Endangered species under Schedule 1 of the TSC Act (NSW), but is not listed in the ESP Act (Cth). The Green-Leaved Rose Walnut has a ROTAP code of 2VCi (Briggs & Leigh 1996), indicating that the species has a national geographic range of less than 100km. It is described as Vulnerable, with less than 1000 plants known from conservation reserves (Briggs & Leigh 1996).

During the field survey the Green-Leaved Rose Walnut was recorded in Brush Box forest and rainforest at four locations within the study area:

- properties in Oola Place backing onto the existing Highway;
- south-facing slopes between the Brunswick River and the sewage treatment plant;
- slopes below Banana Road; and
- along Old Stock Route Road near Billinudgel.

Whilst it is unclear how many individual specimens of the Green-leaved Rose Walnut will be removed by the proposal, or whether a "*viable local population*" will be affected, it is clear that a number of individuals will require removal for the proposal. Given the uncertainties with respect to the definition of a "*viable local population*" of this species, it is assumed

(adopting a 'precautionary' approach) that such a population exists in this locality, even if only consisting of a few individuals, and that one or more of these small populations could be "*placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Green-leaved Rose Walnut has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

Green-Leaved Rose Walnut is distributed north from Maclean, but occurs mainly on the eastern margin of the Mt Warning shield. As only a few individuals will be removed by the proposal, it appears that the area of "*known habitat*" to be "*removed or modified*" is not significant.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The Route A2 alignment (Brunswick to Yelgun) will require the removal of some individuals of Green-Leaved Rose Walnut on properties in Oola Place backing onto the existing highway, on slopes below Banana Rd and on south-facing slopes between the Brunswick River Bridge and the Sewage Treatment Works.

However, whilst some known and potential habitat for this species will require removal for the proposal, "*known habitat*" for this species will not "*become isolated from interconnecting or proximate areas of habitat*". Indeed, if roads were to constitute a barrier for this species, the existing Pacific Highway would already fulfil that function.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Green-leaved Rose Walnut. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Green-leaved Rose Walnut is known from only one conservation reserve, the Maclean Reserve, in the North Coast region (WBM Oceanics 1996). It is also considered likely to occur in Brunswick Heads NR (A Benwell *pers comm*).

Given that the Green-leaved Rose Walnuts is listed as an Endangered species under Schedule 1 of the TSC Act, and that it appears to occur in only one or two reserves on the North Coast, this species would not appear to be "*adequately represented in conservation*

reserves (or other similar protected areas) in the region".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for the Green-leaved Rose Walnut could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The distribution of the Green-Leaved Rose Walnut is poorly known. It has been recorded north from Maclean, but mainly occurs on the eastern side of the Mt Warning Sheild. Route A2 is encompassed within the "*known distribution*" of this species.

Consequently, the Green-Leaved Rose Walnut is not considered to occur *"at the limit of its known distribution"* along the proposed road corridor nor in the study area.

CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to the Green-leaved Rose Walnut, are discussed in detail above.

The proposed road corridor would require the removal of up to thirteen adult Green-leaved Rose Walnut trees at several locations in the study area. As a consequence, the proposal has the potential to involve the imposition of "*a significant effect*" on this species at these localities.

A Species Impact Statement is required for the activity with respect to the Green-leaved Rose Walnut.

3.1.8 Stinking Cryptocarya	*Cryptocarya foetida*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

Stinking Cryptocarya is a small to medium rainforest tree (Quinn *et al* 1995). This species has been recorded from near Iluka on the north coast of NSW and north to Fraser Island in Queensland, where it occurs in littoral rainforest on old sand dunes, and in subtropical rainforest over slate and occasionally basalt derived soils, at altitudes below 150m.

In NSW, Stinking Cryptocarya is listed as a Vulnerable species under Schedule 2 of the TSC Act, and it is also listed as Vulnerable under the ESP Act (Cth). Stinking Cryptocarya

has a ROTAP code of 3VCi (Briggs & Leigh 1996), indicating that the species has a national geographic range of over 100km. It is described as Vulnerable, with less than 1000 plants known to occur in conservation reserves (Briggs & Leigh 1996).

During the field surveys conducted for this project, Stinking Cryptocarya was recorded at three locations in the study area:

- west of the existing Highway within Brunswick Heads NR;
- east of the existing Highway within Brunswick Heads NR; and
- on south-facing slopes between Brunswick Heads NR and the sewage treatment works.

A total of 13 plants are to be removed for the proposal, all of which are juveniles less than 1.5m high. Considerable numbers of other individuals are present in the vicinity, however, including in Brunswick Heads Nature Reserve. It is possible that "*a viable local population*" of this species will "*be placed at risk of extinction*" as a result of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Stinking Cryptocarya has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

The distribution of Stinking Cryptocarya occurs from near Iluka on the north coast of NSW north to Fraser Island in Queensland. Stinking Cryptocarya has also been recorded in the Tweed Heads Remnant Bushland Inventory (*in prep*). Stinking Cryptocarya occurs in most littoral rainforest remnants from the Ballina area north to the Queensland border, and the species extends inland to a few areas such as Mooball SF and Inner Pocket NR, where it tends to be very rare.

Given the extent of the NSW North Coast region, and of Stinking Cryptocarya in rainforest remnants in the region, as well as the distribution of this species in the immediate vicinity, it does not appear that "*a significant area of known habitat*" for the species "*is to be modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The Route A2 alignment (Brunswick to Yelgun) will require the removal of 13 individuals of Stinking Cryptocarya west of the existing highway within Brunswick Heads NR and from south-facing slopes between the Brunswick Heads NR and the sewage treatment works plant.

The removal of this small section of habitat will cause very minor fragmentation along the alignment edge and in the vegetation connecting Brunswick Heads Nature Reserve with vegetation further to the north. Given the existing Pacific Highway alignment is not considered likely to isolate "*currently interconnecting or proximate areas of habitat*" for this species.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Stinking Cryptocarya. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

In the North Coast region (IBRA 1995), Stinking Cryptocarya is known from five Nature Reserves (Table 10). It has also been recorded in Mooball SF north of Brunswick Heads.

Notwithstanding these populations, the Queensland Nut is classified as Vulnerable under the TSC Act, and therefore does not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 10 The extent of reservation of Stinking Cryptocarya *Cryptocarya foetida* in the NSW North Coast region (Quinn *et al* 1995; Sheringham & Westaway 1995; Briggs & Leigh 1996; WBM Oceanics 1996).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
Nature Reserves		
Brunswick Heads NR	1km N of Brunswick Heads	<1000 plants reserved
Broken Head NR	20km SSE of Brunswick Heads	<1000 plants reserved
Tyagarah NR	immediately S & SE of Brunswick Heads	<1000 plants reserved
Iluka NR	52km NE of Grafton	not accurately known
Ukerebagh NR	Ukerebagh Island, Tweed Heads	<1000 plants reserved
Inner Pocket NR	~11.5km NW of Brunswick Heads	not accurately known

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for Stinking Cryptocarya could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

Stinking Cryptocarya occurs from near Iluka on the north coast of NSW to Fraser Island in Queensland. Route A2 is encompassed within the "*known distribution*" of this species, with records from the north, south and southwest of the study area (Quin *et al* 1995).

Consequently, Stinking Cryptocarya cannot be considered to occur *"at the limit of its known distribution"* along the proposed road corridor.

CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular reference to Stinking Cryptocarya, are discussed in detail above.

The proposed upgrade of the Pacific Highway, Brunswick to Yelgun, will involve the removal of approximately 13 Stinking Cryptocarya trees at 2 locations along the proposed road corridor. As a consequence, the project has the potential to involve the imposition of "*a significant effect*" on this species at these localities.

A Species Impact Statement is required for the activity with respect to the Stinking Cryptocarya.

3.1.9 Spiny Gardenia	*Randia moorei*	Endangered (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Spiny Gardenia is a shrub or small tree to 10m high. This species is known from the Lismore area in NSW, north to the Logan River in southern Queensland, where it occurs in subtropical, riverine and littoral rainforest on a range of substrates, including deep alluvial, basalt and slate derived soils (Quinn *et al* 1995). It has been recorded at twenty-three locations in NSW, and eight in Queensland (Quinn *et al* 1995).

The Spiny Gardenia is listed as an Endangered species under Schedule 1 of the TSC Act and as an Endangered species on Schedule 1 of the ESP Act (Cth). It has a ROTAP code of 3ECi (Briggs & Leigh 1996), indicating that the species has a national geographic range of over 100km. It is described as Endangered, with less than 1000 plants known to occur in conservation reserves (Briggs & Leigh 1996). The Spiny Gardenia was recorded at three locations during field investigations in the study area:

- Hilans Corner
- Brunswick NR east of the existing Highway; and
- Brunswick NR west of the existing Highway.

Individuals which occur in the Brunswick NR east of the existing Highway and in the Hilans Corner area are located outside the proposed road corridor and will not be affected by the proposal.

Conversely, two individuals recorded in Brunswick Heads NR on the eastern side of the existing Highway are located immediately adjacent to Route A2. It is uncertain at this stage whether these individuals can be retained or if they will require removal. However, a range of measures will be implemented to ensure either their *in situ* conservation (if possible), or their retention in the general vicinity through transplanting and rehabilitation. A number of other Spiny Gardenias were recorded at this locality, although

these individuals were situated well outside the proposed road corridor and will not be affected by the proposal.

It is not likely that "*a viable local population*" of this species will "*be placed at risk of extinction*", due to the small number of individuals that may potentially be removed and the numbers of individuals to be retained.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Spiny Gardenia has been identified as an "*endangered population*" under Part 2 of the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6).

Only a few individuals of Spiny Gardenia will or may require removal, representing an insignificant proportion of the known population and small proportion of the "*known habitat*". Between 10 and 40 individuals have been recorded within Brunswick Heads NR, at the north end of the bridge of the existing Pacific Highway (Quinn *et al* 1995).

Given the design and location elements of the proposal, and the small number of individuals of Spiny Gardenia to be removed, it would appear that the "*area of known habitat*" for this species which "*is to be modified or removed*" as a result of the proposal is not significant with respect "*to the regional distribution of the habitat*" for the Spiny Gardenia.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The proposal appears likely to involve the removal of 2 specimens of Spiny Gardenia in the Brunswick Heads Nature Reserve.

However, (with the possible exception of two individuals located immediately adjacent to the Route A2), whilst some potential and a little known habitat for the species, may require removal for the proposal, no "*known habitat*" will "*become isolated from interconnecting or proximate areas of habitat*". Indeed, if roads were to constitute a barrier for this species, the existing Pacific Highway would already fulfil that function.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Spiny Gardenia. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Within the NSW North Coast region (IBRA 1995), populations of the Spiny Gardenia are reserved in three Nature Reserves (Table 11). However, information regarding reserved population size is currently insufficient to determine the adequacy of representation in these Reserves.

Notwithstanding these records, the Spiny Gardenia is classified as Endangered under the TSC Act, and therefore does not appear to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*".

Table 11 The extent of reservation of the Spiny Gardenia *Randia moorei* in the NSW North Coast region (Quinn *et al* 1995; Sheringham & Westaway 1995; Briggs & Leigh 1996).

Reserve Type & Name	Location in NSW North Coast Region	Size-class of Populations *
Nature Reserves		
Brunswick Heads NR	1km N of Brunswick Heads	<1000 plants reserved
Broken Head NR	20km SSE of Brunswick Heads	<1000 plants reserved
Stotts Island NR	12km NE of Murwillumbah	<1000 plants reserved

* population size-classes after Briggs & Leigh (1996).

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The clearing of native vegetation and relevant habitats for this species is generally recognised as "*a threatening process*". The loss of native vegetation and appropriate habitat for Spiny Gardenia could, theoretically at least, threaten the continued survival species in any locality. Conversely, the proposal has been located and designed specifically to minimise the requirements for the clearing of native vegetation, and in an attempt to minimise the potential threat imposed by this process at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Spiny Gardenia is known from the Lismore area on the north coast of NSW, northwards to the Logan River in southern Queensland (Quinn *et al* 1995). Route A2 is encompassed within the "*known distribution*" of this species, with records from the north, northwest, south and southwest of the study area (Quinn *et al* 1995).

Consequently, the Spiny Gardenia cannot be considered to occur *"at the limit of its known distribution"* along the proposed alignment.

CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species,*

populations or ecological communities, or their habitats", with particular reference to the Spiny Gardenia, are discussed in detail above.

The proposed upgrade of the Pacific Highway, Brunswick to Yelgun, may require the removal of two Spiny Gardenias located close to Route A2 in the Brunswick Heads NR on the western side of the existing Highway. However, this represents only a small proportion of the population at this site. As a consequence, the proposal is not likely to involve the imposition of "*a significant effect*" on this species at this locality.

A Species Impact Statement is not required for the activity with respect to the Spiny Gardenia.

3.2 Threatened Fauna Species

Of the 73 threatened fauna species which have been recorded in the study area or in the locality, or which are included on the list of species by the Director-General of the NP&WS for the Species Impact Statement (SIS) for the proposal, eight have been recorded in the vicinity (see main report) of the proposal, and an additional seven are considered likely to occur in the areas to be affected (Table 12).

3.2.1	Osprey	*Pandion haliaetus*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Osprey occurs on offshore islands and in littoral habitats, terrestrial wetlands and coastal lands of tropical and temperate Australia, often ranging inland along large rivers (Marchant & Higgins 1993). It requires extensive areas of clear open water (fresh, brackish or saline) for fishing, and nests in prominent positions (such as on rocky headlands or cliffs, or in tall trees with dead crowns or stags). Nest sites are usually located within 1km of the coastline, estuaries or rivers, although birds will nest up to 40km from the sea (Marchant & Higgins 1993). This species exhibits high nest site fidelity, returning to the same nest site over successive years.

The Osprey has an apparently disjunct distribution around the Australian coastline, and is more numerous in the north than in the south. It occurs in the north and east of Australia from Broome in WA to the south coast of NSW, in the south from Kangaroo Island to the Great Australian Bight, and from Esperance to Cape Keraudren in the west (Marchant & Higgins 1993). In NSW, the Osprey has a primarily coastal distribution south to Womboyne Lake, but has been occasionally recorded over inland lakes. Numbers decline from the north to the south.

The Osprey was observed during field investigations for the proposal, flying over the Brunswick River on a number of occasions. This species is known to occur throughout the north coast region, and there is evidence of an increase in the population over recent years (Debus 1994). There is evidence of an Osprey nest approximately 2km upstream of the Brunswick River Bridge (Milledge & McKinley 1992), although no recent nesting has been observed.

The Osprey could potentially occur along the proposal given its high mobility, its wide-ranging habits, and its presence in the locality, but is only likely to utilise resources at 2 sites along Route A2, in the vicinity of Marshall's Creek and along the Brunswick River (where it was recorded). In neither instance are the activities of the Osprey likely to be adversely affected by the proposal, and no known or likely nest trees for this species will be removed. It should be noted that the nest identified upstream is located beyond the proposal area and does not appear to be used at present.

There is no evidence of "*a viable local population*" of the Osprey in the vicinity of the proposal, although individuals are present in this locality. It is difficult, if not impossible,

to define what "*a viable local population*" of this species might be. Nevertheless, given the habits of and habitats utilised by the Osprey, and the extremely limited potential for impacts being imposed on this species or its habitats, it is not likely that the proposal will disrupt any "*viable local population of the species*" (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Osprey has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Osprey.

The proposal does not involve "*a significant area of known habitat*" for the Osprey being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

The Osprey, however, is a highly mobile wide-ranging aerial species, and there is no potential for the proposal to impose constraints on this species' movement in the locality. There will not be any loss of nest trees for the Osprey, and the bridges and proposed roads will not significantly reduce the extent of fishing habitat for this species.

Given its high mobility and wide-ranging habits, and given the nature of the proposal, there is no likelihood of any "*area of known habitat*" for the Osprey becoming "*isolated from currently interconnecting or proximate areas of habitat*".

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Osprey. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

There is limited information regarding the occurrence of the Osprey in National Parks (NPs) or Nature Reserves (NRs) in the region. However, given its widespread distribution in

northeastern NSW, it has the potential to occur in coastal conservation reserves in the NSW North Coast region. The Osprey is known to occur widely in suitable habitat in the Murwillumbah and Coffs Harbour/Urunga Forestry Management Areas (MA), and is also expected to occur in the Glen Innes MA (Tanton 1996).

Regardless of the occurrence of Ospreys within conservation reserves, it is not considered likely that this threatened species is "*adequately represented in conservation reserves (or other similar protected areas) in the region*". However, irrespective of the adequacy or otherwise of this species' representation in conservation or other reserves, the proposal will not involve *"a viable local population"* of this species being threatened or *"placed at risk of extinction"*.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised. Measures to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the clearing of vegetation and other habitats for the proposal could potentially or theoretically constitute "*a threatening process*" with respect to the survival and conservation of the Osprey, there will be no loss of habitat or resources for this species as a result of the Pacific Highway Upgrading Program at Brunswick Heads. On this basis, the proposal does not constitute "*a threatening process*" for the Osprey.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Osprey was observed flying over the Brunswick River on a number of occasions during the field investigations, and an Osprey nest has been previously recorded in the locality (Milledge & McKinley 1992). Although this species has an apparently disjunct distribution, it does occur widely around the Australian coast, including throughout the north coast region (Marchant & Higgins 1990).

Given its distribution to the north and south, the Osprey is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Osprey.

Given its high level of mobility, habitat characteristics and lifestyle habits, and given the nature of the proposal and the extremely limited interaction with potential habitats or resources, there is no likelihood that the proposal will involve the imposition of "*a significant effect*" on the Osprey or on its habitat.

A Species Impact Statement is not required for the proposal with respect to the Osprey.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Bush-hen inhabits thick undergrowth of rank grass or Lantana *Lantana camara* thickets associated with permanent or semi-permanent waterbodies or streams (such as creeks, rivers, ponds, swamps, waterholes, dams, lakes, freshwater wetlands, road-side ditches - Fraser & Mendel 1976; Marchant & Higgins 1993; Muranyi 1994). The maximum distance a Bush-hen has been recorded from a water source is 500m (Blakers *et al* 1984), whilst the average distance is 100m (Muranyi 1994).

The Bush-hen appears to be restricted to the coast and nearby ranges of northeastern Australia, from the Daly River to Cape York, and south to Evans Head (Schodde & Tidemann 1986). In NSW, it is restricted to the Northern Rivers district (Marchant & Higgins 1993), from the Tweed Heads/Murwillumbah area, south to Evans Head, and inland to Woodenbong (Muranyi 1994). One historic record (in 1864) exists for the Clarence River, Grafton (Boles 1976), but there are no other known from this locality. In the NSW North Coast region, the Bush-hen is known to occur in the Tweed, Brunswick and Richmond River valleys (Gilmore & Parnaby 1994).

The Bush-hen was not recorded during field investigations for the proposal, it has been recorded from the general area during previous surveys, at North Ocean Shores (BSPC 1992; Kinhill 1996). On this basis, the Bush-hen could occur in the vicinity of the proposal, in suitable habitat along Marshall's Creek. However, this locality is already affected by the existing Highway and by clearing and development along the Creek, and the relatively low tolerance of the Bush-hen to disturbance will militate against its occurrence at this site. Similarly, the levels of disturbance and noise along the Brunswick River render this area generally unsuitable for the Bush-hen.

There is no evidence for the presence of "*a viable local population*" of the Bush-hen along the proposal (Route A2), and minimal likelihood of individuals of this species being present in habitat adjacent to the existing Highway. It is not likely that the proposal would disrupt any "*viable local population of the species*" (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Bush-hen has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal intersects only an extremely small proportion of the "*regional distribution*" of potential habitat for the Bush-hen, and no "*known habitat*" for the species. The proposal will not involve "*a significant area of known habitat*" being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

The construction of major roads through relevant habitat for the Bush-hen, particularly across watercourses such as Marshall's Creek, could theoretically provide a barrier to movement for this species. Conversely, the Bush-hen is able to fly between areas of suitable habitat, and the proposal will therefore not isolate areas of potential habitat for this species. Furthermore, the proposal involves additional roadworks at a locality which is already disturbed by the existing Pacific Highway and other developments, and will not involve the imposition of a novel barrier (*ie* will not isolate "*an area of known habitat .. from currently interconnecting or proximate areas of habitat*").

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Bush-hen. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

Little information is available on the distribution of the Bush-hen "*in conservation* reserves", but it does occur in the Murwillumbah and Urbenville forestry MAs, and may occur in the Coffs Harbour/Urunga MAs (Tanton 1996). On the basis of its distribution in northeastern NSW, it is considered likely to occur in coastal and ranges conservation reserves in the NSW North Coast region.

Regardless of the occurrence of Bush-hens within reserves of the region, it is not likely that this threatened species is "*adequately represented in conservation reserves (or other similar protected areas*". Furthermore, irrespective of the adequacy or otherwise of this species' representation in conservation or other reserves, the proposal will not involve any "*viable local population*" of this species being "*placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised. Measures to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the clearing of native vegetation (particularly dense riparian vegetation) and the construction of major roads across watercourses theoretically constitute "*threatening processes*" for the Bush-hen, the proposal has specifically been located so as to avoid the imposition of additional barriers to movement and to minimise the extent of native vegetation which is to be cleared. With respect to the Bush-hen and its habitats, the proposal is not "*recognised as a threatening process*".

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Bush-hen is distributed over the northeastern part of Australia, and in NSW is restricted to the Northern Rivers district (Marchant & Higgins 1990). In the NSW North Coast region, this species is known from the Tweed, Brunswick and Richmond River Valleys (Gilmore & Parnaby 1994), the proposal may therefore be located at or near the southern distributional limit of this species.

Whilst the Bush-hen may be at or near the southern "*limit of its known distribution*" in this locality, the proposal will not reduce or affect the species' range.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Bush-hen.

Given the existing levels of disturbance associated with the watercourses which could potentially provide habitat for the Bush-hen in the vicinity of the proposal, and given the location and design of the proposal to minimise the potential for a reduction in habitat or in movement capability for the Bush-hen, it is not likely that the proposed roadworks will involve the imposition of "*a significant effect*" on this species.

A Species Impact Statement is not required for the proposal with respect to the Bush-hen.

3.2.3	Pied Oystercatcher	*Haemantopus longirostris*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Pied Oystercatcher is a coastal species, which roosts and forages on sandy beaches, mudflats and sandbanks. Birds also roost in sheltered inlets and lagoons and occasionally in mangroves (Marchant & Higgins 1993). Suitable nesting habitat for this species includes mainland sandy beaches, sand-bars and estuaries, immediately above the high water mark, as well as on sand dunes (Marchant & Higgins 1993; Lauro & Nol 1995). Whilst the movements of this species are poorly known, there is apparently some seasonal movement between the mainland and offshore islands (Marchant & Higgins 1993).

The Pied Oystercatcher is distributed along the entire Australian coastline, including offshore islands (Marchant & Higgins 1993). Sites of significance which support substantial numbers of birds are generally located in the southeastern portion of this species' range, and include The Coorong in southeastern SA, the Derwent River estuary in Tasmania and Corner Inlet in Victoria (Marchant & Higgins 1993). The species is known from the Tweed, Brunswick and Richmond River estuaries in the NSW North Coast region (Gilmore & Parnaby 1994).

The Pied Oystercatcher was recorded along the Brunswick River on mudflats during field investigations for the proposal, and other surveys in the general area have also recorded this species (Cathcart 1991; Milledge & McKinley 1992; Oehlman 1997). The only area of habitat for the Pied Oystercatcher which will be affected by Route A2 is located on the northern and southern shores of the Brunswick River. A small area of mangroves and mud flats will be removed on both shores for the road construction, but no nesting habitat will be removed.

Whilst Pied Oystercatchers were recorded in the vicinity of the proposed bridge across the Brunswick River, there is no evidence for the presence of "*a viable local population*" of this

species along Route A2. Furthermore, given the mobility of the species and the extremely small area of potential habitat that will be affected, there is no likelihood that the proposal will disrupt any "*viable local population*" of the Pied Oystercatcher (if one exists), or that any such population would be "*likely to be placed at risk of extinction*" as a result of the proposal.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Pied Oystercatcher has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Pied Oystercatcher.

The proposal does not involve "*a significant area of known habitat*" for the Pied Oystercatcher being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Whilst the proposal will involve removal of a small area of potential or "*known habitat*" for the Pied Oystercatcher at the Brunswick River crossing, there is no prospect of the proposal disrupting the movements of this mobile bird species. There is no likelihood that an area of either potential or "*known habitat*" will "*become isolated from currently interconnecting or proximate areas of habitat*" for the Pied Oystercatcher.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Pied Oystercatcher. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

There is little information regarding the occurrence of the Pied Oystercatcher "*in conservation reserves*" in the region. On the basis of its known distribution in coastal NSW, however, this species is likely to occur in coastal conservation reserves in the NSW North Coast region.

Conversely, it is not considered likely that the Pied Oystercatcher is "*adequately represented in conservation reserves (or other similar protected areas) in the region*", given its mobility and moderate densities. The adequacy or otherwise of this species' representation in conservation or other reserves is of little or no relevance, because the proposal will not involve a "*viable local population*" of the Pied Oystercatcher being "*placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the removal of habitat for threatened species is generally recognised as a "*threatening process*", the proposal will involve only the removal of an extremely small portion of suitable habitat for the Pied Oystercatcher. Given the small area of habitat to be affected, the proposed rehabilitation of mangrove habitats in the immediate vicinity, the considerable extent of suitable habitat in the locality and the high mobility of the Pied Oystercatcher, the proposed activity cannot be regarded as "*a threatening process*" with respect to this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Pied Oystercatcher was recorded along the Brunswick River during the field investigations and is known to occur in the locality (Cathcart 1991; Milledge & McKinley 1992; Oehlman 1997). This species is distributed along the entire coast of NSW (Marchant & Higgins 1993), and into Queensland and Victoria.

Given its extensive distribution north and south of the proposal, the Pied Oystercatcher is not "*at the limit of its known distribution*" in this locality. Furthermore, the proposal will not reduce or affect the distributional range of the Pied Oystercatcher, irrespective of whether it "*is at the limit of its known distribution*" or not.

Conclusion

The eight factors which must be considered under s.5A the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Pied Oystercatcher.

The proposal will involve a small reduction in habitat for the Pied Oystercatcher, but will also involve the rehabilitation of mangroves in the immediate vicinity. Furthermore, there are extensive mangroves, mudflats, beaches and sand spits in the locality, and the Pied Oystercatcher is a highly mobile species. There is no likelihood that "*a viable local population*" of this species will be adversely affected by the proposal, and no likelihood of "*a significant effect*" being imposed upon this species.

A Species Impact Statement is not required for the proposal with respect to the Pied Oystercatcher.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Sooty Oystercatcher is a coastal species, inhabiting rocky shorelines, coral cays and reefs and occasionally sandy beaches (Marchant & Higgins 1993). Unlike the Pied Oystercatcher, this species is common in areas supporting rocky headlands and cliffs (Marchant & Higgins 1993). It commonly roosts and nests on offshore islands (Marchant & Higgins 1993). Breeding sites are usually different to roosting and wintering sites, with seasonal movements of birds common (Marchant & Higgins 1993). This species forages both diurnally and nocturnally on a range of prey, including molluscs, worms, crustaceans and small fish, depending on availability (Marchant & Higgins 1993).

The Sooty Oystercatcher displays a patchy distribution along the entire Australian coast, including rocky offshore islands which provide particularly suitable habitat (Marchant & Higgins 1993). Sites of significance which support substantial numbers of this species are generally located in the southern and southeastern portions of the continent, and include the Eyre Peninsula and Kangaroo Island in South Australia, and Corner Inlet in Victoria (Marchant & Higgins 1993). The Sooty Oystercatcher is distributed in small numbers along the entire NSW coastline, but is restricted mainly to offshore roosting and breeding sites (Marchant & Higgins 1993) and mainland rocky shorelines.

The Sooty Oystercatcher was not recorded during field investigations for this proposal, but is known from the general area (NP&WS Wildlife Atlas and NSW Bird Atlassers). Whilst this species may occur along the coastline in the vicinity, there are no resources or appropriate habitats for the Sooty Oystercatcher along Route A2, and no habitats or resources will be affected by the proposal.

There is no evidence for the presence of "*a viable local population*" of the Sooty Oystercatcher along the proposal. Furthermore, it is difficult, if not impossible, to define what "*a viable local population*" of this species might be. Nevertheless, given the habits of and habitats utilised by the Sooty Oystercatcher it is not likely that the proposal would disrupt any "*viable local population of the species*" (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Sooty Oystercatcher has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). The proposal does not support any relevant habitat or resources for the Sooty Oystercatcher.

The proposal does not involve "*a significant area of known habitat*" for the Sooty Oystercatcher being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Given the habitat requirements of the Sooty Oystercatcher, no suitable habitat will be removed by the proposal, and the bridge and roadworks will not provide a barrier to movement for this species. As a consequence, there is no likelihood of any habitat becoming "*isolated from currently interconnecting or proximate areas of habitat*" for this species.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Sooty Oystercatcher. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

There is little information regarding the occurrence of the Sooty Oystercatcher "*in conservation reserves*" in the region. On the basis of its known distribution in coastal NSW, however, this species is likely to occur in coastal conservation reserves in the NSW North Coast region.

Conversely, it is not considered likely that the Sooty Oystercatcher is "*adequately represented in conservation reserves (or other similar protected areas) in the region*", given its mobility and moderate densities. The adequacy or otherwise of this species' representation in conservation or other reserves is of little or no relevance, because the proposal will not involve a "*viable local population*" of the Sooty Oystercatcher being "*placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the removal of habitat for threatened species is generally recognised as a "*threatening process*", the proposal will involve only the removal of an extremely small portion of suitable habitat for the Sooty Oystercatcher. Given the small area of habitat to be affected, the proposed rehabilitation of mangrove habitats in the immediate vicinity, the considerable extent of suitable habitat in the locality and the high mobility of the Sooty Oystercatcher, the proposed activity cannot be regarded as "*a threatening process*" with respect to this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Sooty Oystercatcher was recorded along the Brunswick River during the field investigations and is known to occur in the locality (Cathcart 1991; Milledge & McKinley 1992; Oehlman 1997). This species is distributed along the entire coast of NSW (Marchant & Higgins 1993), and into Queensland and Victoria.

Given its extensive distribution north and south of the proposal, the Sooty Oystercatcher is not "*at the limit of its known distribution*" in this locality. Furthermore, the proposal will not reduce or affect the distributional range of the Sooty Oystercatcher, irrespective of whether it "*is at the limit of its known distribution*" or not.

Conclusion

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular relevance to the Sooty Oystercatcher, are discussed in detail above.

The proposal does not involve the removal or modification of any habitat or resources for the Sooty Oystercatcher. On this basis, and given the mobility of the species, it cannot be construed as likely that the proposal will involve the imposition of "*a significant effect*" on the Sooty Oystercatcher.

A Species Impact Statement is not required for the proposal with respect to the Sooty Oystercatcher.

3.2.5	Rose-crowned Fruit-dove	*Ptilinopus regina*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Rose-crowned Fruit-dove is a strictly arboreal bird inhabiting sub-tropical and dry rainforest, mangroves, riverine forest, beachside scrub and eucalypt forests with rainforest elements (Lindsay 1992; Gilmore & Parnaby 1994; Higgins & Davies 1996). It prefers large expanses of forest, but does occur in smaller remnants (Higgins & Davies 1996). The Rose-crowned Fruit-dove is frugivorous, feeding on a wide variety of rainforest fruits, particularly figs (Higgins & Davies 1996). It forages, roosts and nests in the upper canopy of trees (Lindsey 1992).

The Rose-crowned Fruit-Dove occurs across northern and eastern coastal Australia, from the Kimberleys in the Northern Territory to Cape York, and south to Port Stephens in NSW (Lindsey 1992; Gilmore & Parnaby 1994). It occasionally occurs as far south as Sydney (Lindsey 1992) and there are other records of this species from the NSW east coast, to the Hunter Valley (Gilmore & Parnaby 1994).

The Rose-crowned Fruit-dove was not recorded during field investigations for the proposal, but has been recorded in the general area in the previous surveys for the Ocean Shores development (BSPC 1996) and is included on the NP&WS Wildlife Atlas. Whilst the proposal will involve the removal of some open forest and rainforest communities, particularly in the Smokey Valley area north of the Brunswick River, the extent of these vegetation communities to be affected is relatively small given their distribution within the locality. Furthermore, the proposal has been located and designed so as to minimise the clearing of vegetation required, and to focus the effects of the proposal in areas which are already disturbed as a result of the existing Pacific Highway and agricultural and/or other developments.

As a consequence, the area of potential habitat for the Rose-crowned Fruit-dove which will or may be affected by the proposal is limited, and the potential for the proposal to impose any impacts upon this species has been minimised.

There is no evidence for the presence of "*a viable local population*" of the Rose-crowned Fruit-dove along the proposal, and no likelihood for any such population being dependent on the resources present along Route A2. It is not likely that the proposal would disrupt any "*viable local population*" of the Rose-crowned Fruit-dove (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Rose-crowned Fruit-dove has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Rose-crowned Fruit-dove.

The proposal does not involve "*a significant area of known habitat*" for the Rose-crowned Fruit-dove being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Whilst the proposal will involve the removal of some rainforest and other forest communities, and will probably require the removal of some feeding resources for the Rose-crowned Fruit-dove, the potential habitats which may be affected are close to the existing Pacific Highway and to developments in this locality. Furthermore, the Rose-crowned Fruit-dove is a highly mobile species, and is not likely to be impeded in its movements through the locality as a result of the proposal. Neither potential nor "*known habitat*" for the Rose-crowned Fruit-dove "*is likely to become isolated from currently interconnecting or proximate areas of habitat*" for this species as a consequence of the proposal.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Rose-crowned Fruit-dove. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Rose-crowned Fruit-dove has been recorded widely through the Murwillumbah, Casino, Coffs Harbour/Urunga, Urbenville and Dorrigo Forestry MAs (Tanton 1996). On the basis of its widespread distribution along coastal NSW and in the coastal ranges, it is also likely to occur in conservation reserves within the NSW North Coast region.

Nevertheless, the Rose-crowned Fruit-dove is not considered likely to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*". Conversely, the adequacy or otherwise of this species' representation in conservation or other reserves "*in the region*" is of little or no relevance, as the proposal will not cause a "*viable local population*" of this species "*to be placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the clearing of forest and rainforest communities, and the removal of food resources, is doubtless regarded as "*a threatening process*" with respect to the Rose-crowned Fruit-dove, the proposal will involve only minimal impacts in this regard. The selection of Route A2 as the preferred option was in part predicated on a desire to minimise the removal of forest and rainforest resources (such as are required by the Rose-crowned Fruit-dove), and to minimise the potential for the proposal to impose threats to the survival or conservation of this species. On this basis, whilst road construction in general could potentially constitute "*a threatening process*" for this species, the Brunswick Heads proposal has been designed to avoid the imposition of any threats upon this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Rose-crowned Fruit-dove occurs across northern and eastern coastal Australia, and in NSW is distributed from the Queensland border to Port Stephens (Lindsey 1992; Gilmore & Parnaby 1994).

Given that its distribution extends north and south of the proposal, the Rose-crowned Fruit-dove is not "*at the limit of its known distribution*" in this locality.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Rose-crowned Fruit-dove.

The proposal will require the removal of some rainforest and open forest vegetation, and will (to a limited extent) reduce the availability of resources for the Rose-crowned Fruit-dove. Conversely, only a small area of habitat and resource is to be removed, and the extent of suitable or potential habitat in the locality is substantial. The proposal is not

likely to involve the imposition of "*a significant effect*" on this species, or on its habitat or resources, given the wide-ranging nature of the Rose-crowned Fruit-dove.

A Species Impact Statement is not required for the proposal with respect to the Rose-crowned Fruit-dove.

3.2.6	Wompoo Fruit-dove	*Ptilinopus magnificus*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Wompoo Fruit-dove occurs mainly in large patches of undisturbed tall tropical or subtropical rainforest in eastern Australia and Papua New Guinea, but also sporadically in monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Higgins & Davies 1996). It mostly forages in the dense canopy of large rainforest trees, taking fruits of a wide variety of trees, palms, vines and epiphytes. The Wompoo Fruit-dove appears to make seasonal altitudinal movements and local movements in response to food availability (Date & Recher 1989).

The three distinct populations of the Wompoo Fruit-dove in Australia occur on Cape York Peninsular in northern Queensland, in northeast Queensland (south of the Cape), and in eastern Australia, south of 20's (Higgins & Davies 1996). In NSW, this species is widespread east of the Great Divide from the Northern Rivers region (north of Lismore), south to the Hunter Valley, although it is rare south of Coffs Harbour and the Dorrigo Plateau. It occurs widely in suitable habitat in the NSW North Coast region, and has been recorded from the Tweed, Brunswick, Richmond, Clarence, Bellinger, Macleay, Hastings, Manning and Hunter Valleys (Gilmore & Parnaby 1994).

The Wompoo Fruit-dove was not recorded during field investigations for the proposal. However, it is known from the Brunswick River Valley (NP&WS Wildlife Atlas; Birds Australia and Bird Atlassers databases; Gilmore & Parnaby 1994) and has been recorded previously at Taggert's Hill (MKES 1994). Whilst the proposal will involve the removal of some open forest and rainforest communities, particularly in the Smokey Valley area north of the Brunswick River, the extent of these vegetation communities to be affected is relatively small given their distribution within the locality. Furthermore, the proposal has been located and designed so as to minimise the clearing of vegetation required, and to focus the effects of the proposal in areas which are already disturbed as a result of the existing Pacific Highway and agricultural and/or other developments.

As a consequence, the area of potential habitat for the Wompoo Fruit-dove which will or may be affected by the proposal is limited, and the potential for the proposal to impose any impacts upon this species has been minimised.

There is no evidence for the presence of "*a viable local population*" of the Wompoo Fruit-dove along the proposal, and no likelihood for any such population being dependent on the resources present along Route A2. It is not likely that the proposal would disrupt any "*viable local population*" of the Wompoo Fruit-dove (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Wompoo Fruit-dove has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Wompoo Fruit-dove.

The proposal does not involve "*a significant area of known habitat*" for the Wompoo Fruit-dove being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Whilst the proposal will involve the removal of some rainforest and other forest communities, and will probably require the removal of some feeding resources for the Wompoo Fruit-dove, the potential habitats which may be affected are close to the existing Pacific Highway and to developments in this locality. Furthermore, the Wompoo Fruit-dove is a highly mobile species, and is not likely to be impeded in its movements through the locality as a result of the proposal. Neither potential nor "*known habitat*" for the Wompoo Fruit-dove "*is likely to become isolated from currently interconnecting or proximate areas of habitat*" for this species as a consequence of the proposal.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Wompoo Fruit-dove. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Wompoo Fruit-dove is known to occur in the Murwillumbah, Casino, Grafton, Coffs Harbour/Urunga, Urbenville and Dorrigo forestry MAs (Tanton 1996), and is known to occur widely in the vicinity of the proposal. On the basis of its apparently widespread distribution in northeastern NSW, it is considered also likely to occur in many of the conservation reserves in the NSW North Coast region.

Nevertheless, the Wompoo Fruit-dove is not considered likely to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*". Conversely, the adequacy or otherwise of this species' representation in conservation or other reserves "*in the region*" is of little or no relevance, as the proposal will not cause a "*viable local population*" of this species "*to be placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation

by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the clearing of forest and rainforest communities, and the removal of food resources, is doubtless regarded as "*a threatening process*" with respect to the Wompoo Fruit-dove, the proposal will involve only minimal impacts in this regard. The selection of Route A2 as the preferred option was in part predicated on a desire to minimise the removal of forest and rainforest resources (such as are required by the Wompoo Fruit-dove), and to minimise the potential for the proposal to impose threats to the survival or conservation of this species. On this basis, whilst road construction in general could potentially constitute "*a threatening process*" for this species, the Brunswick Heads proposal has been designed to avoid the imposition of any threats upon this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Wompoo Fruit-dove occurs along the east coast of Australia from the tip of Cape York to the Illawarra district, rarely being recorded south of Newcastle (Lindsey 1992).

Given that its distribution extends to the north and south of the proposal, the Wompoo Fruit-dove is not "*at the limit of its known distribution*" in this locality.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Wompoo Fruit-dove.

The proposal will require the removal of some rainforest and open forest vegetation, and will (to a limited extent) reduce the availability of resources for the Wompoo Fruit-dove. Conversely, the extent of habitat and resource removal in this locality is minimal, and the extent of suitable or potential habitat in the locality is considerable. The proposal is not likely to involve the imposition of "*a significant effect*" on this species, or on its habitat or resources, given the wide-ranging nature of the Wompoo Fruit-dove.

A Species Impact Statement is not required for the proposal with respect to the Wompoo Fruit-dove.

3.2.7	Superb Fruit-dove	*Ptilinopus superbus*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Superb Fruit-Dove inhabits rainforest and adjacent eucalypt forest and mangroves along the east coast of Australia, from the tip of Cape York to Rockhampton, with vagrants reaching southeastern Victoria and Tasmania (Lindsey 1992). It prefers coastal lowland forest, being strongly arboreal and feeding on a variety of rainforest fruits, particularly laurels (Lindsey 1992). It is generally recorded at the warmest rainforest sites, and usually below 300m asl (Gilmore & Parnaby 1994). Nests are constructed in dense foliage up to 30m above the ground (Lindsey 1992).

The Superb Fruit-Dove occurs regularly along coastal areas of the Northern Rivers region of NSW, becoming rarer to the south (Higgins & Davies 1996). This species is known from a number of valleys in NSW, including the Tweed, Brunswick, Clarence, Macleay and Hunter River catchments (Gilmore & Parnaby 1994).

The Superb Fruit-dove was not recorded during the field investigations conducted for this proposal. This species has been recorded at Linwood to the south of the proposal and at Inner Pocket to the northwest (NP&WS Atlas), and could potentially occur in the general vicinity given the presence of suitable habitat. Whilst the proposal will involve the removal of some open forest and rainforest communities, particularly in the Smokey Valley area north of the Brunswick River, the extent of these vegetation communities to be affected is relatively small given their distribution within the locality. Furthermore, the proposal has been located and designed so as to minimise the clearing of vegetation required, and to focus the effects of the proposal in areas which are already disturbed as a result of the existing Pacific Highway and agricultural and/or other developments.

As a consequence, the area of potential habitat for the Superb Fruit-dove which will or may be affected by the proposal is limited, and the potential for the proposal to impose any impacts upon this species has been minimised.

There is no evidence for the presence of "*a viable local population*" of the Superb Fruit-dove along the proposal, and no likelihood for any such population being dependent on the resources present along Route A2. It is not likely that the proposal would disrupt any "*viable local population*" of the Superb Fruit-dove (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Superb Fruit-dove has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Superb Fruit-dove.

The proposal does not involve "*a significant area of known habitat*" for the Superb Fruit-dove being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Whilst the proposal will involve the removal of some rainforest and other forest communities, and will probably require the removal of some feeding resources for the Superb Fruit-dove, the potential habitats which may be affected are close to the existing Pacific Highway and to developments in this locality. Furthermore, the Superb Fruit-dove is a highly mobile species, and is not likely to be impeded in its movements through the

locality as a result of the proposal. Neither potential nor "*known habitat*" for the Superb Fruit-dove "*is likely to become isolated from currently interconnecting or proximate areas of habitat*" for this species as a consequence of the proposal.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Superb Fruit-dove. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Superb Fruit-dove has been recorded widely in the Murwillumbah, Casino, Coffs Harbour/Urunga and Urbenville forestry MAs (Tanton 1996), and elsewhere in the region (Birds Australia; NP&WS Wildlife Atlas). On the basis of its distribution in northeastern NSW, it is likely that this species is represented in coastal conservation reserves in the NSW North Coast region.

Nevertheless, the Superb Fruit-dove is not considered likely to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*". Conversely, the adequacy or otherwise of this species' representation in conservation or other reserves "*in the region*" is of little or no relevance, as the proposal will not cause a "*viable local population*" of this species "*to be placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the clearing of forest and rainforest communities, and the removal of food resources, is doubtless regarded as "*a threatening process*" with respect to the Superb Fruit-dove, the proposal will involve only minimal impacts in this regard. The selection of Route A2 as the preferred option was in part predicated on a desire to minimise the removal of forest and rainforest resources (such as are required by the Superb Fruit-dove), and to minimise the potential for the proposal to impose threats to the survival or conservation of this species. On this basis, whilst road construction in general could potentially constitute "*a threatening process*" for this species, the Brunswick Heads proposal has been designed to avoid the imposition of any threats upon this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Superb Fruit-dove occurs along the east coast of Australia, from the tip of Cape York to Tasmania (Higgins & Davies 1996; Lindsey 1992), regularly occurring along coastal areas of the Northern Rivers region of NSW (Higgins & Davies 1996).

Given that its distribution extends to the north and south of the proposal, the Superb Fruit-dove is not "*at the limit of its known distribution*" in this locality.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Superb Fruit-dove.

The proposal will require the removal of some rainforest and open forest vegetation, and will (to a limited extent) reduce the availability of resources for the Superb Fruit-dove. Conversely, the extent of habitat and resource removal in this locality is minimal, and the extent of suitable or potential habitat in the locality is considerable. The proposal is not likely to involve the imposition of "*a significant effect*" on this species, or on its habitat or resources, given the wide-ranging nature of the Superb Fruit-dove.

A Species Impact Statement is not required for the proposal with respect to the Superb Fruit-dove.

3.2.8	Collared Kingfisher	*Todiramphus chloris*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Collared or Mangrove Kingfisher is a poorly known species. It inhabits mangroves where it nests in termite mounds (Gilmore & Parnaby 1994), with tree hollows and earthen banks used on occasions (Lindsey 1992). Each family group has strongly defined territory (Bell 1960) of around 1.5ha (Gilmore & Parnaby 1994). This species has been observed feeding on lizards and crabs (Bell 1960).

The Collared Kingfisher is distributed along the north and central Australian coast (Lindsey 1992), from approximately Shark Bay in Western Australia to Port Macquarie in NSW. In the NSW North Coast region, this species' distribution includes the proposal area and coastal habitats throughout the region, and is known from the Tweed, Brunswick and Richmond River Valleys (Gilmore & Parnaby 1994).

The Collared Kingfisher was not recorded during the fauna investigations conducted for this proposal. However, this species is known from the Brunswick River estuary (Gilmore & Parnaby 1994), and has been recorded previously in the general vicinity of the proposal (Kinhill 1996). Its local distribution is restricted to mangrove communities, and associated tidal flats and pools. Whilst the proposal will require removal of small areas of mangrove forest on the northern and southern shores of the Brunswick River, less than one hectare of this habitat will be removed, and there will also be some rehabilitation of mangrove communities in the immediate vicinity. Given the extent of mangrove forest vegetation in the locality, and the fact that those areas of mangrove forest which are to be removed are already disturbed by the existing Pacific Highway, it is not likely that any individuals of the Collared Kingfisher would be adversely affected.

There is no evidence for the presence of "*a viable local population*" of the Collared Kingfisher in the mangrove forest on the Brunswick River, or elsewhere along the proposal. The proposal will involve the removal or modification of only a very small proportion of potential habitat for this species in the locality, involving areas which are already modified or disturbed as a result of the existing Pacific Highway and other developments. Consequently, it cannot be construed as likely that the proposal will involve the imposition of impacts upon individuals or "*a viable local population*" of the Collared Kingfisher (if one is present) such as to significantly disrupt its life cycle and render any such population "*likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Collared Kingfisher has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Collared Kingfisher.

The proposal does not involve "*a significant area of known habitat*" for the Collared Kingfisher being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Whilst the proposal will involve removal of a small area of potential or "*known habitat*" for the Collared Kingfisher at the Brunswick River crossing, there is no prospect of the proposal disrupting the movements of this mobile bird species. There is no likelihood that an area of either potential or "*known habitat*" will "*become isolated from currently interconnecting or proximate areas of habitat*" for the Collared Kingfisher.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Collared Kingfisher. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

There are no known records of the Collared Kingfisher occurring in State Forests, NPs or NRs in the vicinity or "*in the region*". Comprehensive data regarding the distribution of the Collared Kingfisher, based on appropriate surveys in reserves is generally lacking, but it is likely that the species does occur widely in coastal conservation reserves in the NSW North Coast region.

Regardless of their presence within reserves of the region, it is not likely that the Collared Kingfisher is "*adequately represented in conservation reserves (or other similar protected areas)*". In any case, the proposal will not involve any individuals or a "*viable local population*" of this species (if one is present) being "*placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the removal of habitat for threatened species is generally recognised as a "*threatening process*", the proposal will involve only the removal of an extremely small portion of suitable habitat for the Collared Kingfisher. Given the small area of habitat to be affected, the proposed rehabilitation of mangrove habitats in the immediate vicinity, the considerable extent of suitable habitat in the locality and the high mobility of the Collared Kingfisher, the proposal cannot be regarded as "*a threatening process*" with respect to this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Collared Kingfisher is distributed along the north and central Australian coast, from approximately Shark Bay in Western Australia to Port Macquarie in NSW (Lindsey 1992).

Given "*its known distribution*" north and south of the proposal, the Collared Kingfisher is not "*at the limit of its known distribution*" in this locality.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Collared Kingfisher.

The proposal will involve a small reduction in habitat for the Collared Kingfisher, but will also involve the rehabilitation of mangroves in the immediate vicinity. Furthermore, there are extensive mangroves, mudflats, beaches and sand spits in the locality, and the Collared Kingfisher is a highly mobile species. There is no likelihood that "*a viable local population*" of this species will be adversely affected by the proposal, and no likelihood of "*a significant effect*" being imposed upon this species.

A Species Impact Statement is not required for the proposal with respect to the Collared Kingfisher.

3.2.9	Mangrove Honeyeater	*Lichenostomus fasciogularis*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Mangrove Honeyeater (like the Collared Kingfisher) is a little known species, which inhabits estuarine closed mangrove forest, where it roosts and nests in horizontal forks of mangrove trees (Gilmore & Parnaby 1994). Whilst generally sedentary, individuals may wander locally in search of flowering plants, including flowering shrubs in towns adjacent

to mangrove communities (Blakers *et al* 1984). The Mangrove Honeyeater feeds on nectar, insects, molluscs and crabs.

The Mangrove Honeyeater has a restricted distribution along the eastern Australian coast (Lindsey 1992), from approximately Townsville in the north to Port Macquarie in NSW. This species is distributed throughout the North Coast region, particularly in the Tweed, Brunswick, Richmond, Clarence, Macleay and Hastings River Valleys (Gilmore & Parnaby 1994). However, its distribution is restricted by the availability of suitable mangrove habitat.

The Mangrove Honeyeater was not recorded during field investigations for the proposal. However, this species is known from the Brunswick River estuary (Gilmore & Parnaby 1994), and has been recorded previously in the general area of the proposal (Kinhill 1996). Whilst the proposal will require removal of small areas of mangrove forest on the northern and southern shores of the Brunswick River, less than one hectare of this habitat will be removed, and there will also be some rehabilitation of mangrove communities in the immediate vicinity. Given the extent of mangrove forest vegetation in the locality, and the fact that those areas of mangrove forest which are to be removed are already disturbed by the existing Pacific Highway, it is not likely that even any individuals of the Mangrove Honeyeater would be adversely affected.

There is no evidence for the presence of "*a viable local population*" of the Mangrove Honeyeater along the proposal. The proposal will involve the removal or modification of only a very small proportion of potential habitat for this species in the locality, involving areas which are already modified or disturbed as a result of the existing Pacific Highway and other developments. Consequently, it cannot be construed as likely that the proposal will involve the imposition of impacts upon individuals or "*a viable local population*" of the Mangrove Honeyeater (if one is present) such as to significantly disrupt its life cycle and render any such population "*likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Mangrove Honeyeater has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Mangrove Honeyeater.

The proposal does not involve "*a significant area of known habitat*" for the Mangrove Honeyeater being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

to mangrove communities (Blakers *et al* 1984). The Mangrove Honeyeater feeds on nectar, insects, molluscs and crabs.

The Mangrove Honeyeater has a restricted distribution along the eastern Australian coast (Lindsey 1992), from approximately Townsville in the north to Port Macquarie in NSW. This species is distributed throughout the North Coast region, particularly in the Tweed, Brunswick, Richmond, Clarence, Macleay and Hastings River Valleys (Gilmore & Parnaby 1994). However, its distribution is restricted by the availability of suitable mangrove habitat.

The Mangrove Honeyeater was not recorded during field investigations for the proposal. However, this species is known from the Brunswick River estuary (Gilmore & Parnaby 1994), and has been recorded previously in the general area of the proposal (Kinhill 1996). Whilst the proposal will require removal of small areas of mangrove forest on the northern and southern shores of the Brunswick River, less than one hectare of this habitat will be removed, and there will also be some rehabilitation of mangrove communities in the immediate vicinity. Given the extent of mangrove forest vegetation in the locality, and the fact that those areas of mangrove forest which are to be removed are already disturbed by the existing Pacific Highway, it is not likely that even any individuals of the Mangrove Honeyeater would be adversely affected.

There is no evidence for the presence of "*a viable local population*" of the Mangrove Honeyeater along the proposal. The proposal will involve the removal or modification of only a very small proportion of potential habitat for this species in the locality, involving areas which are already modified or disturbed as a result of the existing Pacific Highway and other developments. Consequently, it cannot be construed as likely that the proposal will involve the imposition of impacts upon individuals or "*a viable local population*" of the Mangrove Honeyeater (if one is present) such as to significantly disrupt its life cycle and render any such population "*likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Mangrove Honeyeater has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Mangrove Honeyeater.

The proposal does not involve "*a significant area of known habitat*" for the Mangrove Honeyeater being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Whilst the proposal will involve removal of a small area of potential or "*known habitat*" for the Mangrove Honeyeater at the Brunswick River crossing, there is no prospect of the proposal disrupting the movements of this mobile bird species. There is no likelihood that an area of either potential or "*known habitat*" will "*become isolated from currently interconnecting or proximate areas of habitat*" for the Mangrove Honeyeater.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Mangrove Honeyeater. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Mangrove Honeyeater is known to occur in the Cook Island NR off the Tweed coast (Gilmore & Parnaby 1994), but is not known from the Murwillumbah Forestry MA (Tanton 1996). On the basis of its distribution in northeastern NSW, it is considered likely to occur in other coastal conservation reserves in the NSW North Coast region, where mangrove forest is present.

Regardless of their presence within reserves of the region, it is not likely that the Mangrove Honeyeater is "*adequately represented in conservation reserves (or other similar protected areas)*". In any case, the proposal will not involve any individuals or a "*viable local population*" of this species (if one is present) being "*placed at risk of extinction*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

Whilst the removal of habitat for threatened species is generally recognised as a "*threatening process*", the proposal will involve only the removal of an extremely small portion of suitable habitat for the Mangrove Honeyeater. Given the small area of habitat to be affected, the proposed rehabilitation of mangrove habitats in the immediate vicinity, the considerable extent of suitable habitat in the locality and the high mobility of the Mangrove Honeyeater, the proposed activity cannot be regarded as "*a threatening process*" with respect to this species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Mangrove Honeyeater is distributed along the east coast of Australia from approximately Townsville in the north to Port Macquarie in NSW (Lindsey 1992).

Given that this species' distribution encompasses the proposal and extends to the north and south, and given the distribution of potential or suitable habitat in the region, the Mangrove Honeyeater is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Mangrove Honeyeater.

Given its high level of mobility, habitat characteristics and lifestyle habits, and given the nature of the proposal and the extremely limited interaction with potential habitats or resources, there is no likelihood that the proposal will involve the imposition of "*a significant effect*" on the Mangrove Honeyeater or on its habitat.

The proposal will involve a small reduction in habitat for the Mangrove Honeyeater, but will also involve the rehabilitation of mangroves in the immediate vicinity. Furthermore, there are extensive mangroves, mudflats, beaches and sand spits in the locality, and the Mangrove Honeyeater is a highly mobile species. There is no likelihood that "*a viable local population*" of this species will be adversely affected by the proposal, and no likelihood of "*a significant effect*" being imposed upon this species.

A Species Impact Statement is not required for the proposal with respect to the Mangrove Honeyeater.

3.2.10 Koala *Phascolarctos cinereus*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Koala favours open eucalypt forest and woodland communities, although it occurs in a range of disturbed and modified habitats, including agricultural and pastoral land throughout northeastern NSW and southeastern Queensland. Whilst at any one locality the Koala predominantly feeds in a small range of preferred food tree species, this species has been recorded feeding in or resting in a total of 120 species of eucalypt and 40 other tree species (Lee & Martin 1988; Phillips 1990; Reed & Lunney 1990). Of the eucalypts present within the proposal study area, the species mostly preferred by the Koala and considered of greatest relevance for it include Tallow-wood *E microcorys*, Swamp Mahogany *E robusta* and Forest Red Gum *E tereticornis* (Lee & Martin 1988; Reed & Lunney 1990; Pahl *et al* 1990; this study).

The Koala is distributed from western Victoria through coastal and eastern NSW to the base of Cape York, in several large but disjunct distributional ranges. The southern populations in Victoria and southern NSW are isolated from populations in northern NSW and southern Queensland by substantial gaps in the distribution of the species. Northeastern NSW and southeastern Queensland constitute one of the major concentrations of Koalas in Australia (Phillips 1990), with most of the focus of Koala populations in the state being located within the NSW North Coast region, particularly at Port Stephens, Port Macquarie, Coffs Harbour and in Tweed Shire (Phillips 1990). The species is known from the Tweed, Brunswick, Richmond, Clarence, Bellinger, Macleay, Hastings, Camden Haven, Manning and Hunter Valleys in the NSW North Coast region (Gilmore & Parnaby 1994).

Individual Koalas were recorded on two occasions during field investigations for the proposal, and Koala scats were detected in both Brunswick and Billinudgel Nature Reserves. In addition, Koalas are regularly, if infrequently, reported as roadkills along the existing Pacific Highway (R Oehlman *pers comm*), near Coolamon Scenic Drive and south of Dirty Flat Road (near the Billinudgel Nature Reserve). No evidence for the presence of "*a viable local population*" of the Koala has been obtained along Route A2, or in the general vicinity. Whilst there are clearly some individuals in the locality, and there is probably a breeding population in the locality, the low frequency of records and of roadkills on the existing Pacific Highway suggest that any population in this location is relatively widely and sparsely distributed.

Irrespective of whether a "*viable local population*" of the Koala is present along Route A2 or in the general vicinity, the proposal will not involve any disruption to the life cycle of any such population such as to render it "*at risk of extinction*". Indeed, given that the existing Pacific Highway does not provide safe means of passage for the Koala, and that the proposal involves the installation of appropriate wildlife fencing and fauna underpasses, it is likely that the proposal will increase the viability of any "*local population*" of the Koala in this vicinity, rather than reduce it. The area of potential or known resources to be removed is minimal in terms of the regional and local distribution of resources for this species.

Furthermore, it is not considered likely that the viability of any "*local population*" of the Koala would be dependent on an ability to cross the Pacific Highway in an east-west direction. Given the low likelihood of Koalas currently successfully undertaking such a crossing, and the nature and distribution of habitat for this species in the locality, as well as the existing constraints on this species (such as residential developments and industrial and infrastructure developments), the proposal is not considered likely to disrupt any "*viable local population*" to the extent that it may be placed "*at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Koala has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Koala.

The proposal does not involve "*a significant area of known habitat*" for the Koala being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

As noted above, the population of Koalas in this locality appears widely distributed and sparse, and suitable habitat is patchily distributed throughout the locality. Areas regarded as of potential or known value for the Koala include the vegetated lands to the west of the existing Pacific Highway (north of the Brunswick River) and to a lesser extent the scattered vegetation to the south of Dirty Flat Road, as well as lands to the northeast of the proposal (including Billinudgel Nature Reserve). Whilst there are not likely to be significant Koala movement 'corridors' east and west across the existing Pacific Highway or of the proposal, Koala mortalities have occurred on the Pacific Highway. It would therefore appear that the existing Pacific Highway constitutes a potential barrier for the movement of this species, and may provide some isolation of patches of habitat for this species.

Conversely, the proposal involves the provision of fauna underpasses at strategic locations, designed particularly to provide safe passage across the new roadway for Koalas and

terrestrial mammal species. As a consequence, not only does the proposal not involve "*an area of known habitat*" becoming "*isolated from currently interconnecting or proximate areas of habitat*" for the Koala, but it is intended to improve the connection between potential or known habitat on the two sides of the Highway.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Koala. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Koala has been recorded in Brunswick and Billinudgel NRs. It is also known to occur in the Oxley Wild Rivers, Border Ranges and Bundjalung NPs (Tanton 1996), and in a range of other "*conservation reserves ... in the region*". The Koala is known to occur in Murwillumbah, Casino, Grafton, Coffs Harbour/Urunga, Urbenville and Dorrigo Forestry MAs (Tanton 1996).

Irrespective of the occurrence of Koalas within reserves, this species is not regarded as "*adequately represented in conservation reserves (or other similar protected areas) in the region*". Furthermore, the adequacy or otherwise of this species' representation in conservation or other reserves is of little or no relevance, as the proposal will not involve a "*viable local population*" of this species being "*placed at risk of extinction*" or even threatened in the locality.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

For the Koala, major roads can constitute "*a threatening process*" on the basis of the removal of habitat and resources, and on the basis of imposing barriers to movement and/or sites of high mortality. These features of the construction and operation of roads as "*threatening processes*" for the Koala are of general and theoretical concern, but have been specifically addressed in the case of the proposal both by the selection of Route A2 as the preferred option and by measures to provide safe passage for Koalas across the finished road. Route A2 was selected in part to avoid the imposition of a new barrier to wildlife movements in an east-west direction, and will involve the provision of fauna underpasses and wildlife fencing to provide safe passage for Koalas and other fauna.

Furthermore, the proposal involves only the removal of a few potential food trees for the Koala, with areas considered likely to provide more critical food resources (predominantly to the west) being avoided.

Given the approaches to both the selection of the preferred route for the proposal, and the incorporation of impact amelioration measures for the Koala, the proposal has been designed to avoid the imposition of "*a threatening process*" on Koalas at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Koala is known to occur throughout the locality of the proposal, and has been recorded in the vicinity of the existing Pacific Highway. In NSW, Koala populations are concentrated in the northeastern corner of the State (Phillips 1990) although this species is also sparsely located in other areas (Strahan 1995). Major concentrations of the Koala are present both north of the proposal in southeastern Queensland and the Tweed Shire area, and south of the proposal at Port Stephens, Port Macquarie and Coffs Harbour (Phillips 1990, Reed & Lunney 1990).

Given the known distribution of the Koala, this species is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which must be considered under s.5A of the EP&A Act in determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", are discussed in detail above, with respect to the Koala.

The proposal will involve the removal of only a very small number of potential food trees for the Koala, and has been designed to avoid the imposition of any barriers to movement for this species. Given the limited impacts upon habitat or resources for this species, and the intent to provide safe passage in an east-west direction for Koalas as part of the proposal, it is not likely that "*a significant effect*" will be imposed upon this species.

A Species Impact Statement is not required for the proposal with respect to the Koala.

3.2.11 Squirrel Glider *Petaurus norfolcensis* Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Squirrel Glider is a small arboreal marsupial, inhabiting dry sclerophyll forest and woodland, including Box-Ironbark, Blackbutt-Bloodwood, Grey Gum-Grey Ironbark-Spotted Gum and River Red Gum communities (Suckling 1995; Maxwell *et al* 1996). Where it inhabits mixed species stands, there are invariably some smooth-barked and high nectar-producing eucalypts present (Menkhorst *et al* 1988). The Squirrel Glider also inhabits tall coastal forest and banksia woodland in the northeast of its distribution (Maxwell *et al* 1996).

The Squirrel Glider appears to spatially partition habitat with the Sugar Glider *Petaurus breviceps*, with the Squirrel Glider feeding in the upper canopy and the Sugar Glider at lower levels (Davey 1984). The Squirrel Glider feeds predominantly on nectar and pollen, supplementing its diet with sap, invertebrates and seeds of the Golden Wattle (Suckling 1995). It is dependent on the presence of medium sized tree-hollows for shelter and nesting (Suckling 1995).

The Squirrel Glider occurs in a broad band along the east coast of Australia, including coastal Queensland (south of the Cape York Peninsular), through coastal NSW to central Victoria (Strahan 1995). The Squirrel Glider is primarily coastal in distribution in northern NSW.

There is one record of this species from field investigations conducted for the proposal, on the eastern side of the Brunswick Heads Bypass. The species has been recorded elsewhere within 10km of the proposal (NP&WS Wildlife Atlas), although it has not been recorded from other fauna surveys in the vicinity of the proposal. Whilst there may be a family group of Squirrel Gliders present in the vicinity of the Brunswick Heads Bypass, the

primary environmental impact which may be imposed upon this species at this locality will have already arisen as a consequence of the existing Bypass construction. Duplication of the Brunswick Heads Bypass will involve only a relatively small increase in the area of vegetation or the number of trees which are to be removed. The Bypass also provides a barrier to the movement of Squirrel Gliders across it in most places, and the duplication is not likely to exacerbate that situation.

Whilst one individual Squirrel Glider was recorded along the Brunswick Heads Bypass, it is not clear whether there is "*a viable local population*" present at this locality. In any case, given the existing disturbance provided by the present Brunswick Heads Bypass, and the lack of evidence for this species in the area of the proposed upgrade from Brunswick to Yelgun, it does not appear likely that the proposal will involve the disruption of any "*viable local population*" such that it would be likely "*to be placed at risk of extinction*". Whilst it is possible for adverse impacts to be imposed upon a "*viable local population*" of the Squirrel Glider (if one is present in this locality), it is not considered likely that any such affect would be sufficient to render that population extinct.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Squirrel Glider has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Squirrel Glider.

The proposal does not involve "*a significant area of known habitat*" for the Squirrel Glider being "*modified or removed*".

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

In the southern part of the proposal (the Brunswick Heads Bypass duplication), which involves the only records of Squirrel Gliders in the immediate vicinity, some isolation of potential habitat for Squirrel Gliders may have already occurred as a result of the Bypass construction. Given that the duplication will involve the construction of a second carriage-way immediately to the west of the existing Bypass, and will involve the removal of only a few trees in this locality, it is not considered likely that the proposed duplication will significantly increase the barrier effect. Moreover, it is proposed to retain large trees at strategic locations in the central nature strip along the road, to provide an intermediate gliding station for Squirrel Gliders to cross the Bypass.

Given the existing Brunswick Heads Bypass construction, it is considered that habitat to the east and west of the Bypass are already isolated. Consequently, the proposal to duplicate the Bypass will not involve habitat becoming "*isolated from currently interconnecting or proximate areas of habitat*". Furthermore, measures are proposed

which may reduce the existing barrier effect of the Brunswick Heads Bypass for Squirrel Gliders.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Squirrel Glider. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Squirrel Glider has been recorded in Washpool, Oxley Wild River and Yuraygir NPs (Tanton 1996). It is known to occur in Casino, Grafton, Coffs Harbour/Urunga, Urbenville and Dorrigo Forestry MAs, and is likely to occur in the Murwillumbah MA (Tanton 1996). On the basis of its apparent distribution in northeastern NSW, it is considered likely to also occur in coastal conservation reserves in the NSW North Coast region.

Regardless of the occurrence of Squirrel Gliders within reserves of the region, it is not considered likely that this threatened species is "*adequately represented in conservation reserves (or other similar protected areas) in the region*". Furthermore, this species' representation in conservation or other reserves is of little or no relevance, as the proposal will not cause a "*viable local population*" of this species "*to be placed at risk of extinction*" as discussed above.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

For the Squirrel Glider, major roads can constitute "*a threatening process*" on the basis of the removal of habitat and resources, and on the basis of imposing barriers to movement and/or sites of high mortality. These features of the construction and operation of roads as "*threatening processes*" for the Squirrel Glider are of general and theoretical concern, but have been specifically addressed in the case of the proposal both by the selection of Route A2 as the preferred option and by measures to provide safe passage for Squirrel Gliders across the finished road.

The proposal involves only the removal of a few potential food trees for the Squirrel Glider, with areas considered likely to provide more critical food resources (predominantly to the west) being avoided.

Given the approaches adopted to both the selection of the preferred route for the proposal, and the incorporation of impact amelioration measures specifically directed at the Squirrel Glider, the proposal has been designed to avoid the imposition of "*a threatening process*" on Squirrel Gliders at this locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Squirrel Glider was recorded east of the Brunswick Heads bypass alignment during the field investigations, and is known to occur within the locality of the proposal (NP&WS Wildlife Atlas). This species occurs in a broad band along the east coast of Australia, including coastal Queensland through coastal NSW to central Victoria (Strahan 1995).

Given that this species' distribution encompasses the proposal and extends beyond it, the Squirrel Glider is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular relevance to the Squirrel Glider, are discussed in detail above.

Whilst one individual Squirrel Glider was recorded along the Brunswick Heads Bypass, and "*a viable local population*" could be present in the locality, the proposed Bypass duplication is not considered likely to significantly increase the threats to this species in this locality. No evidence for the Squirrel Glider was obtained along the proposed Brunswick to Yelgun upgrade, and little or no suitable habitat for this species will be affected by the proposal. Given these considerations, it is not likely that the proposal will involve the imposition of "*a significant effect*" on the Squirrel Glider.

A Species Impact Statement is not required for the proposal with respect to the Squirrel Glider.

3.2.12 Queensland Blossom Bat	*Syconycteris australis*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Queensland Blossom Bat occurs in a variety of habitats, including coastal and subtropical rainforest, eucalypt forest, coastal heathland and *Melaleuca* swamps (Law & Spencer 1995) along the northeastern Australian coastline. Queensland Blossom Bats forage chiefly on nectar in the southern end of their range, but are facultative frugivores and, to a lesser extent, folivores, in northeast Queensland.

Heathland and *Melaleuca* swamps provide critical foraging habitat for this species in the southern part of its range, with favoured food sources including banksias, paperbarks, bottlebrushes and certain eucalypts. Subtropical rainforest and coastal eucalypt forests provide food resources when heaths and paperbarks are not flowering. Queensland Blossom Bats also visit banana plantations and fruit orchards to feed on flowering trees.

The Queensland Blossom Bat is highly mobile and may travel up to 4km from roost sites to exploit these temporally and spatially patchy food resources (Law & Spencer 1995), as well as being apparently migratory in southern parts of its range. It roosts in the sub-canopy foliage of coastal rainforest or moist hardwood forest (Baverstock & Chambers 1992; Law 1993), often adjacent to heathlands utilised for foraging.

The distribution of the Queensland Blossom Bat extends along the east coast of Australia from the tip of Cape York to the mid-north coast of NSW (Law & Spencer 1995). In NSW, it is restricted to the northern coastline from the Queensland border, south to Booti Booti, and west to the Great Dividing Range (Law 1994; Law & Spencer 1995).

Two Queensland Blossom Bats were recorded during field investigations for the proposal, along the Brunswick Heads Bypass and just north of the Brunswick Heads NR. The

species has also been recorded north and south of the proposal area in previous investigations (Gilmore & Associates 1995; Milledge & McKinley 1992; MKES 1994; BSPC 1996).

The Queensland Blossom Bat doubtless forages on the paperbarks and eucalypts in the various woodland and open forest communities associated with the proposal, and doubtless roosts in the rainforest stands present. As detailed in the main fauna and flora report, the proposal has been located and designed to minimise the removal of vegetation (including that of relevance for the Queensland Blossom Bat). Additionally, the preferred route has been selected in part to involve areas which are already disturbed or modified from their original condition, and which therefore will be of less value for species such as the Queensland Blossom Bat. Whilst there will be some removal of resources for foraging and roosting which may be utilised by the Queensland Blossom Bat in this locality, the extent of this potential loss is limited by the location and design of the project.

Although there is no clear evidence for the presence of "*a viable local population*" of the Queensland Blossom Bat in the areas to be affected by the proposal, it is possible that such a population is present. Nevertheless, the proposal does not involve a significant removal of vegetation or of resources which may potentially be of value for this species.

It is not considered likely that the proposal would disrupt any "*viable local population of the species*" (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Queensland Blossom Bat has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Queensland Blossom Bat.

The proposal does not involve "*a significant area of known habitat*" for the Queensland Blossom Bat being "*modified or removed*".

As documented in the main report, the proposal has been located and designed to minimise the extent of native vegetation which requires removal. Only a relatively small area, even in local terms, of suitable rainforest roosting habitat and of woodland and open forest which may be utilised by the Queensland Blossom Bat for foraging requires removal for the proposal.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

Conversely, the Queensland Blossom Bat is a highly mobile species, travelling several kilometres in an evening to forage, and being regarded (in some areas at least) as nomadic or migratory. Consequently, it is not likely that the proposal will involve the imposition of a barrier to movement for this species, and there is no likelihood of "*an area of known habitat*" becoming "*isolated from currently interconnecting or proximate areas of habitat*" for the Queensland Blossom Bat.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Queensland Blossom Bat. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Queensland Blossom Bat has been recorded in the Mt Warning, Nightcap and Lamington NPs, and in coastal reserves such as Myall Lakes, Booti Booti, Bundjalung and Ywaygir NPs. It also is known to occur in Murwillumbah, Casino, Coffs Harbour/Urunga and Urbenville Forestry MAs (Tanton 1996).

The Queensland Blossom Bat appears to be relatively well represented within reserves, although it is not considered likely to be "*adequately represented in conservation reserves (or other similar protected areas) in the region*". Irrespective of the adequacy or otherwise of its representation in conservation or other reserves the proposal will not cause a *"viable local population"* of this species *"to be placed at risk of extinction"* as discussed above.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

The clearing of native vegetation is generally regarded as "*a threatening process*" for native fauna, and the clearing of suitable foraging or roosting habitat for the Queensland Blossom Bat would clearly be regarded in this manner. Conversely, the proposal involves the removal only of a small area of potential feeding or roosting habitat for this species, and the Route A2 alignment was selected in part because it involves areas which are already highly modified or disturbed. Thus, whilst the clearing of native vegetation for road construction and other developments may generally be considered as a "*threatening process*", the proposal has minimised the potential for imposing any threats upon this species by its location and design.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Queensland Blossom Bat has been recorded at two locations during the field investigations, and at a number of locations to the north and south of the study area (Milledge 1993; NP&WS Wildlife Atlas; Tanton 1996). The Queensland Blossom Bat occurs

along the NSW coast from the Queensland border to Booti Booti, near Newcastle NSW (Law & Spencer 1995; Gilmore & Parnaby 1994).

The Queensland Blossom Bat is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular relevance to the Queensland Blossom Bat, are discussed in detail above.

Whilst the Queensland Blossom Bat has been recorded in the vicinity of Route A2, and the proposal will involve the removal of some potential habitat and resources for this species, the extent of potential impacts upon it as a result of the proposal has been limited by appropriate design and impact amelioration measures (including rehabilitation and compensatory habitat). It is not considered likely that "*a significant effect*" will be imposed upon "*a viable local population*" of this species and the proposal is not considered likely to impose any significant threat to the survival of the Queensland Blossom Bat in this locality.

A Species Impact Statement is not required for the proposal with respect to the Queensland Blossom Bat.

3.2.13 Greater Broad-nosed Bat	*Scoteanax rueppellii*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Greater Broad-nosed Bat inhabits eucalypt forests and woodlands, particularly more open communities which suit its relatively direct flight patterns (Hoye & Richards 1995). It generally feeds by flying slowly at low heights, along tree-lined creeks (including through rainforest) and along the ecotone between cleared land and woodland (Hoye & Richards 1995). Most records for this species have been obtained from sclerophyll forest and in woodland habitats rather than rainforest (Gilmore & Parnaby 1994).

The Greater Broad-nosed Bat occurs throughout coastal eastern Australia from southern NSW to Ingham, Queensland (Hall & Richards 1979). Strahan (1995) comments that the range of this species is from north-eastern Victoria to the Atherton Tableland in Queensland, where it occurs in the gully and river systems which drain the Great Dividing Range. In NSW it is restricted to the Great Dividing Range and to the east (Strahan 1995). This species is sparse but widely distributed throughout the NSW North Coast region (Gilmore & Parnaby 1994).

The Greater Broad-nosed Bat was tentatively recorded during field investigations for the proposal, and has been recorded in the immediate vicinity (Milledge & McKinley 1992) and in the surrounding area (NP&WS Wildlife Atlas).

The proposal has been located and designed to minimise the area of forest and woodland communities which must be removed for its construction. On this basis, the removal of potential resources and habitat for the Greater Broad-nosed Bat for the proposal is limited, and it is not considered likely that the proposal would significantly affect this species, if it does indeed occur in the study area.

There is no evidence for the presence of "*a viable local population*" of the Greater Broad-nosed Bat along the proposal. Given the design of the project and the limited amount of vegetation clearing required, it is not considered likely that the proposal would disrupt any

"*viable local population*" of the Greater Broad-nosed Bat (if one exists) to the extent that any such population would be "*likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Greater Broad-nosed Bat has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Greater Broad-nosed Bat.

The proposal does not involve "*a significant area of known habitat*" for the Greater Broad-nosed Bat being "*modified or removed*".

As documented in the main report, the proposal has been located and designed to minimise the extent of native vegetation which requires removal. Only a relatively small area, even in local terms, of suitable roosting habitat and of woodland and open forest which may be utilised by the Greater Broad-nosed Bat for foraging requires removal for the proposal.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

As is the case with the other microchiropteran bats, the Greater Broad-nosed Bat is a highly mobile and relatively wide-ranging species. The proposal will not provide an impediment to movement of Greater Broad-nosed Bats throughout the landscape, and will not involve any potential or "*known habitat*" becoming "*isolated from currently interconnecting or proximate areas of habitat*" for this species. There is no likelihood that the proposal will prevent the Greater Broad-nosed Bat from moving between habitats or resources in this locality.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Greater Broad-nosed Bat. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Greater Broad-nosed Bat has been recorded in the Border Ranges NPs and it is known from the Murwillumbah, Casino, Grafton, Coffs Harbour/Urunga, Urbenville and Dorrigo Forestry MAs (Tanton 1996). On the basis of its distribution through northeastern NSW, this species is also likely to occur in many of the coastal conservation reserves in the NSW North Coast region.

Regardless of its occurrence within reserves, however, it is not considered likely that the Greater Broad-nosed Bat is "*adequately represented in conservation reserves (or other similar protected areas) in the region*", although there are insufficient data in this regard. In any case, the proposal will not involve a "*viable local population*" of this species being "*placed at risk of extinction*", *and its conservation will not be threatened by the proposal.*

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

The clearing of native vegetation is generally regarded as "*a threatening process*" for native fauna, and the clearing of suitable foraging or roosting habitat for the Greater Broad-nosed Bat would clearly be regarded in this manner. Conversely, the proposal involves the removal only of a small area of potential feeding or roosting habitat for this species, and the Route A2 alignment was selected in part because it involves areas which are already highly modified or disturbed. Thus, whilst the clearing of native vegetation for road construction and other developments may generally be considered as a "*threatening process*", the proposal has minimised the potential for imposing any threats upon this species by its location and design.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Greater Broad-nosed Bat was tentatively identified from Anabat II echolocation recordings along the proposed Bypass duplication alignment, and is known to occur in the locality (Milledge & McKinley 1992; NP&WS Wildlife Atlas). This species is restricted to the Great Dividing Range and east of the range in NSW (Strahan 1995), and is distributed throughout the NSW North Coast region (Gilmore & Parnaby 1994).

The Greater Broad-nosed Bat is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular relevance to the Greater Broad-nosed Bat, are discussed in detail above.

Whilst the Greater Broad-nosed Bat has been recorded in the vicinity of Route A2, and the proposal will involve the removal of some potential habitat and resources for this species,

the extent of potential impacts upon it as a result of the proposal has been limited by appropriate design and impact amelioration measures (habitat rehabilitation and compensatory habitat). It is not considered likely that "*a significant effect*" will be imposed upon "*a viable local population*" of this species and the proposal is not considered likely to impose any significant threat to the survival of the Greater Broad-nosed Bat in this locality.

A Species Impact Statement is not required for the proposal with respect to the Greater Broad-nosed Bat.

3.2.14 Little Bent-wing Bat	*Miniopterus australis*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The Little Bent-wing Bat roosts by day in caves and/or artificial structures (such as tunnels, drains *etc*) and depends upon specific cave nursery sites to rear its young and for winter hibernation (Dwyer 1995). All caves utilised by this species are located near relatively large areas of dense vegetation, including rainforest, wet sclerophyll forest or coastal Banksia scrub (Gilmore & Parnaby 1994), and are frequently shared with colonies of the Large Bent-wing Bat. Foraging activities appear to be concentrated between the understorey and canopy of forest vegetation communities.

The distributional range of the Little Bent-wing Bat includes the east coast of Australia, from Cape York in Queensland to the mid-north coast of NSW. In northern NSW, the Little Bent-wing Bat occurs on the coast and ranges, becoming increasingly coastal towards the southern limit of its range. Known nursery caves are largely restricted to the subtropical coastal areas of northeastern NSW, as far south as about Kempsey (Gilmore & Parnaby 1994), although Little Bent-wing Bats have been recorded roosting in artificial structures throughout their range (*eg* at the Balickera Canal north of Raymond Terrace).

This species was tentatively recorded during field investigations for the proposal and has been recorded previously at a number of locations north of the Brunswick River (MKES 1994; BSPC 1996) and along the Brunswick Heads Bypass (Milledge & McKinley 1992) to the south.

The proposal has been located and designed to minimise the area of forest and woodland communities which must be removed for its construction. On this basis, the removal of potential resources and habitat for the Little Bent-wing Bat for the proposal is limited, and it is not considered likely that the proposal would significantly affect this species, if it does indeed occur in the study area. There is no significant roosting habitat for this species along Route A2, with the only potential roosting resources being represented by artificial structures.

There is no evidence for the presence of "*a viable local population*" of the Little Bent-wing Bat along the proposal, and it is not clear what "*a viable local population*" of this species might be in the absence of a "*local*" maternity roost. In any case, given the nature of the areas to be affected by the proposal and the habits of the Little Bent-wing Bat, it is not likely that the proposal would disrupt any "*viable local population of the species*" (if one exists) to the extent that any such population "*is likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Little Bent-wing Bat has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Little Bent-wing Bat.

The proposal does not involve "*a significant area of known habitat*" for the Little Bent-wing Bat being "*modified or removed*".

As documented in the main report, the proposal has been located and designed to minimise the extent of native vegetation which requires removal. Only a relatively small area, even in local terms, of woodland and open forest which may be utilised by the Little Bent-wing Bat for foraging requires removal for the proposal.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

As is the case with the other microchiropteran bats, the Little Bent-wing Bat is a highly mobile and relatively wide-ranging species. The proposal will not provide an impediment to movement of Little Bent-wing Bats throughout the landscape, and will not involve any potential or "*known habitat*" becoming "*isolated from currently interconnecting or proximate areas of habitat*" for this species. There is no likelihood that the proposal will prevent the Little Bent-wing Bat from moving between habitats or resources in this locality.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Little Bent-wing Bat. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Little Bent-wing Bat has been recorded in the Border Ranges NP (Tanton 1996), and is known from the Murwillumbah, Casino, Grafton, Coffs Harbour/Urunga, Urbenville and Dorrigo Forestry MAs (Tanton 1996). On the basis of its apparently widespread distribution in northeastern NSW, it is likely to be present in most of the conservation reserves in the NSW North Coast region.

Regardless of its occurrence within reserves, however, it is not considered likely that the Little Bent-wing Bat is "*adequately represented in conservation reserves (or other similar protected areas) in the region*", although there are insufficient data in this regard. In any case, the proposal will not involve a *"viable local population"* of this species being "*placed at risk of extinction*", *and its conservation will not be threatened by the proposal.*

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

The clearing of native vegetation is generally regarded as "*a threatening process*" for native fauna, and the clearing of suitable foraging or roosting habitat for the Little Bent-wing Bat would clearly be regarded in this manner. Conversely, the proposal involves the removal only of a small area of potential feeding or roosting habitat for this species, and the Route A2 alignment was selected in part because it involves areas which are already highly modified or disturbed. Thus, whilst the clearing of native vegetation for road construction and other developments may generally be considered as a "*threatening process*", the proposal has minimised the potential for imposing any threats upon this species by its location and design.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Little Bent-wing Bat was tentatively recorded within the study area, and is known to occur at numerous locations throughout the North Coast region. In NSW, the Little Bent-wing Bat is distributed from the Queensland border to the Hawkesbury area (Hall & Richards 1979; NP&WS Wildlife Atlas).

The Little Bent-wing Bat is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular relevance to the Little Bent-wing Bat, are discussed in detail above.

Whilst the Little Bent-wing Bat has been recorded in the vicinity of Route A2, and the proposal will involve the removal of some potential habitat and resources for this species, the extent of potential impacts upon it as a result of the proposal has been limited by appropriate design and impact amelioration measures (including habitat rehabilitation and compensatory habitat). It is not considered likely that "*a significant effect*" will be imposed upon "*a viable local population*" of this species and the proposal is not considered likely to impose any significant threat to the survival of the Little Bent-wing Bat in this locality.

A Species Impact Statement is not required for the proposal with respect to the Little Bent-wing Bat.

3.2.15 Eastern Long-eared Bat *Nyctophilus bifax*	Vulnerable (TSC Act)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

This species occurs in a range of habitats, including rainforest, dry sclerophyll forest and riparian communities. Although little is known about the biology and habits of this species, it is known to roost in tree-hollows and dense vegetation, particularly rainforest, and is thought to forage for insects amongst foliage.

The Eastern Long-eared Bat occurs across the north coast of Australia, including an isolated sub-species on the west coast of WA, and along the east coast from Cape York to northern NSW. It is restricted to the northeastern corner of the state (Gilmore & Parnaby 1994), and reaches its southern distributional limit in the North Coast region, with no known records south of Iluka (Gilmore & Parnaby 1994).

This species was recorded during the field investigations for the proposal, and it has been recorded in the locality during previous fauna investigations (Milledge & McKinley 1992; MKES 1994; BSPC 1996; NP&WS Wildlife Atlas).

The proposal has been located and designed to minimise the area of forest and woodland communities which must be removed for its construction. On this basis, the removal of potential resources and habitat for the Eastern Long-eared Bat for the proposal is limited, and it is not considered likely that the proposal would significantly affect this species.

The frequency of records of this species in the immediate vicinity suggests that there is "*a viable local population*" present. Nevertheless, the proposal has been located and designed in a manner to minimise the requirements for removal of or disturbance to forest and woodland communities, and will primarily involve areas which are already disturbed or modified. It is not considered likely that the proposal will involve the disruption of the life cycle of any "*viable local population*" of the Eastern Long-eared Bat to the extent that any such population which may occur in the immediate vicinity would be "*likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in Part 2 of Schedule 1*".

No population of the Eastern Long-eared Bat has been identified as "*an endangered population*" under the TSC Act, and this factor is not relevant to the proposal.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The proposal is located in the NSW North Coast region (IBRA 1995; Section 1.6). On that basis, the proposal involves only an extremely small proportion of the "*regional distribution of the habitat*" of the Eastern Long-eared Bat.

The proposal does not involve "*a significant area of known habitat*" for the Eastern Long-eared being "*modified or removed*".

As documented in the main report, the proposal has been located and designed to minimise the extent of native vegetation which requires removal. Only a relatively small area, even in local terms, of suitable woodland and open forest which may be utilised by

the Eastern Long-eared Bat for foraging and/or roosting requires removal for the proposal.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

In general terms, any development which requires the clearing of native vegetation and fauna habitats has the potential to fragment habitats and resources for threatened fauna and flora, and possibly to provide barriers to movement for threatened species.

As is the case with the other microchiropteran bats, the Eastern Long-eared Bat is a highly mobile and relatively wide-ranging species. The proposal will not provide an impediment to movement of Eastern Long-eared Bats throughout the landscape, and will not involve any potential or "*known habitat*" becoming "*isolated from currently interconnecting or proximate areas of habitat*" for this species. There is no likelihood that the proposal will prevent the Eastern Long-eared Bat from moving between habitats or resources in this locality.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

The Director-General of the NSW NP&WS has not declared any "*critical habitat*" for the Eastern Long-eared Bat. Consequently, this issue is of no relevance to the proposal.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

The Eastern Long-eared Bat has been recorded in Mt Warning NP, and is also known from the Murwillumbah, Casino and Coffs Harbour/Urunga Forestry MAs (Tanton 1996). This species is likely to occur in most of the coastal and ranges conservation reserves in the NSW North Coast region.

Regardless of its occurrence within reserves, however, it is not considered likely that the Eastern Long-eared Bat is "*adequately represented in conservation reserves (or other similar protected areas) in the region*", although there are insufficient data in this regard. In any case, the proposal will not involve a "*viable local population*" of this species being "*placed at risk of extinction*", and its conservation will not be threatened by the proposal.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

As indicated in Section 1.5, the construction and maintenance of roads is not included on Schedule 3 of the TSC Act as a "*key threatening process*". Furthermore, given the nature of the environment in which the proposal is located, it is not considered likely that the proposal will exacerbate those "*threatening processes*" which have been listed (predation by the European Red Fox) or which are currently being considered for listing (the removal of bushrock and predation by Plague Minnow).

The potential for the proposal to constitute "*a threatening process*" for individual threatened species or their habitats has been recognised, and measures, to avoid or minimise any such potential threats have been incorporated into the project.

The clearing of native vegetation is generally regarded as "*a threatening process*" for native fauna, and the clearing of suitable foraging or roosting habitat for the Eastern Long-eared Bat would clearly be regarded in this manner. Conversely, the proposal involves the removal only of a small area of potential feeding or roosting habitat for this species, and

the Route A2 alignment was selected in part because it involves areas which are already highly modified or disturbed. Thus, whilst the clearing of native vegetation for road construction and other developments may generally be considered as a "*threatening process*", the proposal has minimised the potential for imposing any threats upon this species by its location and design.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The Eastern Long-eared Bat was recorded in the study area, and is known to occur in the locality of the proposal (Milledge & McKinley 1992; MKES 1994; BSPC 1996; NP&WS Wildlife Atlas). This species reaches its southern distributional limit in the NSW North Coast region, with no known records south of Iluka (Gilmore & Parnaby 1994). Its northern distributional limit is Cape York (Gilmore & Parnaby 1994).

Given its distribution to the north and south, the Eastern Long-eared Bat is not "*at the limit of its known distribution*" along the proposal.

Conclusion

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*", with particular relevance to the Eastern Long-eared Bat, are discussed in detail above.

Whilst the Eastern Long-eared Bat has been recorded in the vicinity of Route A2, and the proposal will involve the removal of some potential habitat and resources for this species, the extent of potential impacts upon it as a result of the proposal has been limited by appropriate design and impact amelioration measures (including habitat rehabilitation and compensatory habitat). It is not considered likely that "*a significant effect*" will be imposed upon "*a viable local population*" of this species and the proposal is not considered likely to impose any significant threat to the survival of the Eastern Long-eared Bat in this locality.

A Species Impact Statement is not required for the proposal with respect to the Eastern Long-eared Bat.

4 GENERAL CONCLUSION

The eight factors which are required to be considered under s.5A of the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*" as a consequence of the proposed duplication and upgrade of the Pacific Highway at Brunswick Heads is discussed in detail above for the fauna and flora species considered relevant to the proposal.

Whilst the preferred route for the proposal (Route A2) has been selected, located and designed to limit the potential for imposing adverse impacts upon the natural environment, the proposal will unavoidably affect some individuals of six threatened plant species. As discussed in the Flora & Fauna Assessment report (GECon 1998), it is not considered likely that a route for the upgrade of the Pacific Highway could be located through the locality without affecting threatened biota, particularly threatened plants. A detailed route selection process was undertaken early in the project, in an attempt to identify a route for the proposed road which would minimise the imposition of adverse impacts upon the natural environment.

Notwithstanding the impact amelioration measures which are involved in the location, design and construction protocols for the proposal, the imposition of "*a significant effect*" on six threatened plant species appears inevitable. The species which are likely to be affected by the removal of individuals for the proposal include:

- Stinking Cryptocarya (13 individuals);
- Davidson's Plum (approximately 25 individuals);
- Crystal Creek Walnut (up to 5 individuals);
- Green-leaved Rose Walnut (10 individuals);
- Spiny Gardenia (possibly 2 individuals); and
- Red Lilly Pilly (2 individuals).

The s.5A Assessments of Significance with respect to the three other threatened flora species recorded along Route A2 and in the immediate vicinity, and the s.5A Assessments of Significance for threatened fauna known from the study area, conclude that the proposal will not involve the imposition of "*a significant effect*" on these species or on their habitats.

The proposed duplication and upgrade of the Pacific Highway at Brunswick Heads appears likely to involve the imposition of "*a significant effect*" on several threatened flora species. As a consequence, an SIS is required for the proposed activity.

PROPOSED DUPLICATION
of the
BRUNSWICK HEADS BYPASS
&
UPGRADE of the PACIFIC HIGHWAY
BRUNSWICK RIVER to YELGUN

APPENDIX 10

Significant Biota and Vegetation Communities within the Route Selection Study Area

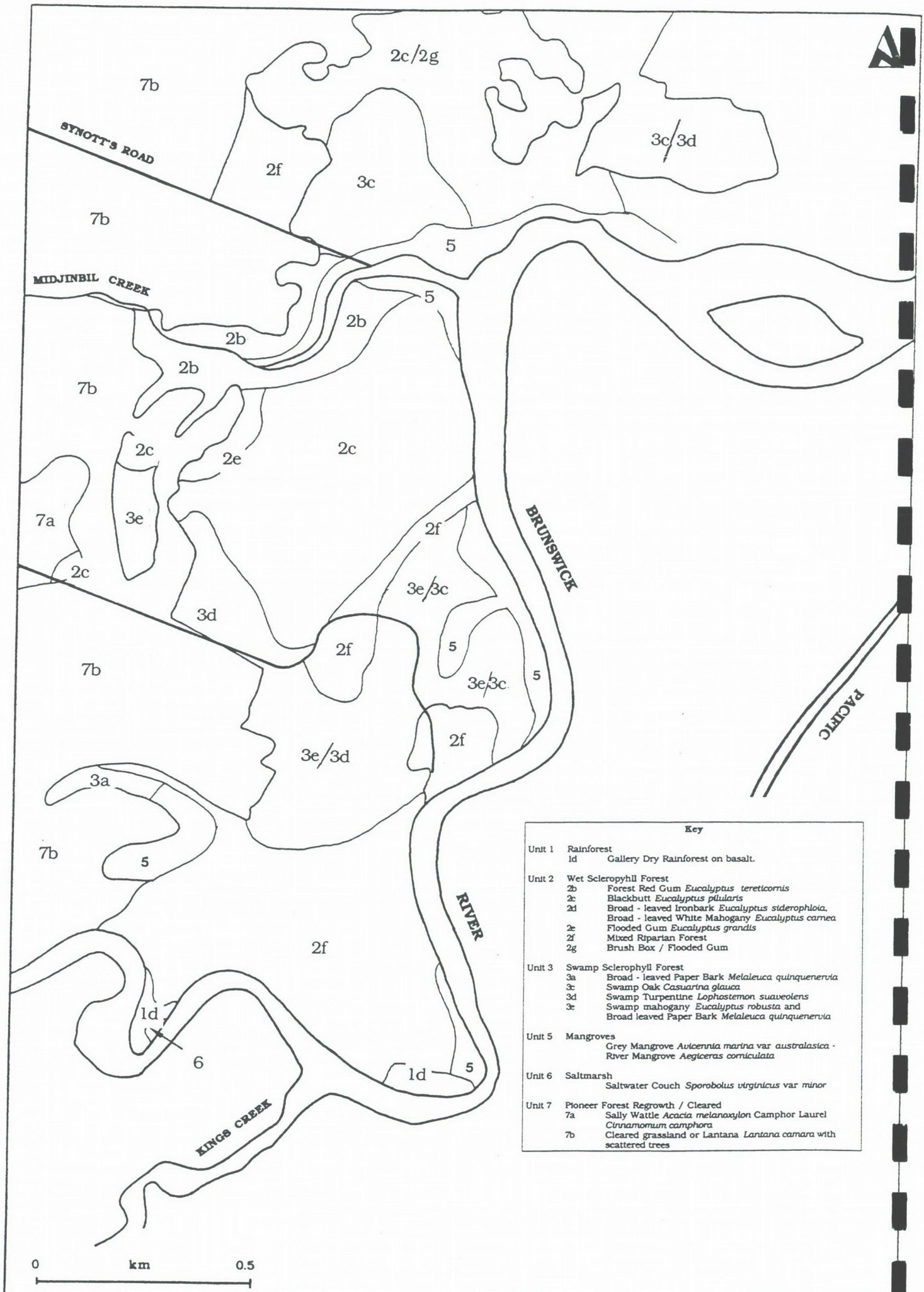

FIGURE A Vegetation communities west of the Brunswick River to the vicinity of Coolamon Scenic Drive and Vallances Road.

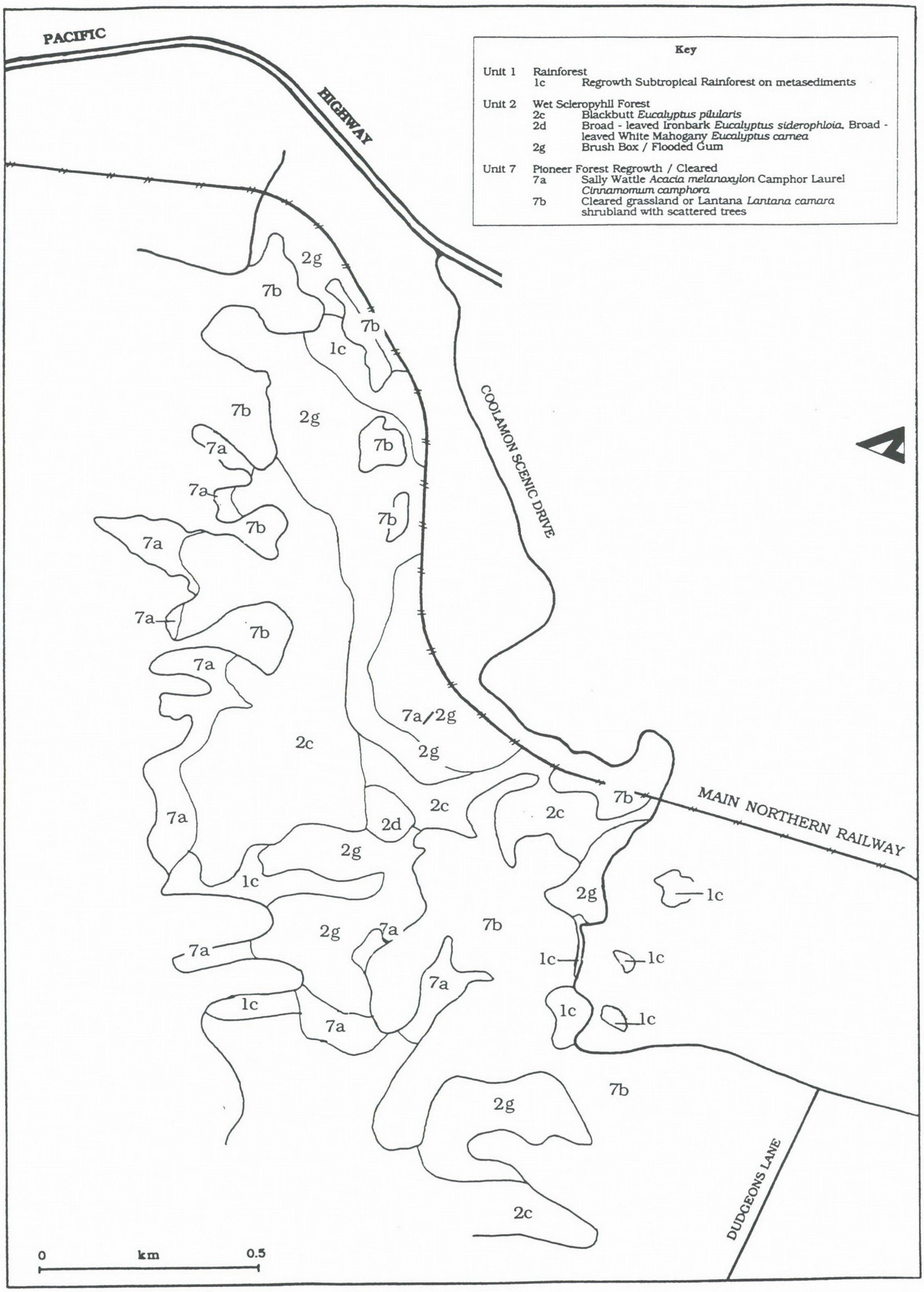

FIGURE B Vegetation communities on the Hillans Corner Ridge, north of Coolamon Scenic Drive.

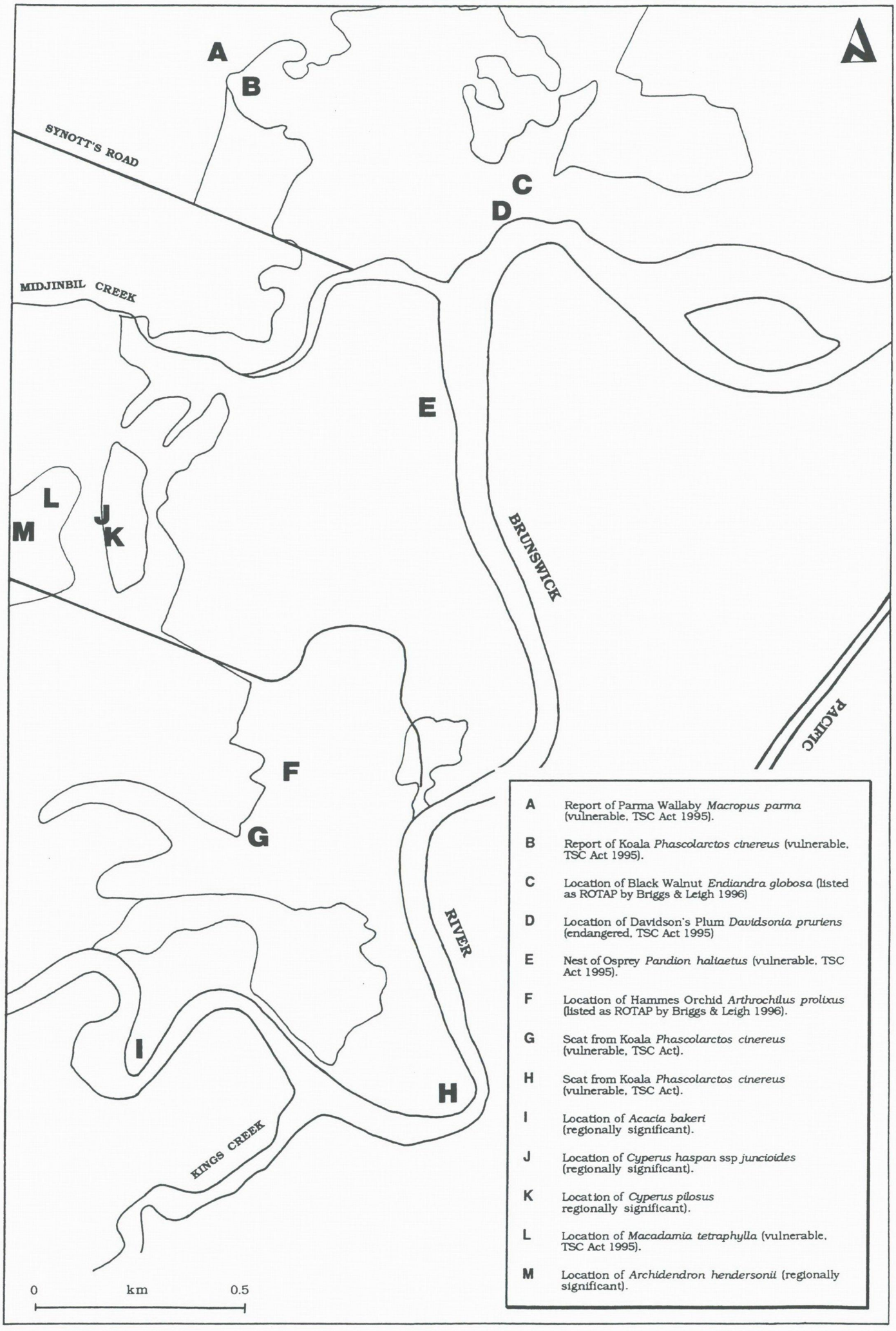

FIGURE C Location of significant fauna and flora west of the Brunswick River to the vicinity of Coolamon Scenic Drive and Vallance Road.

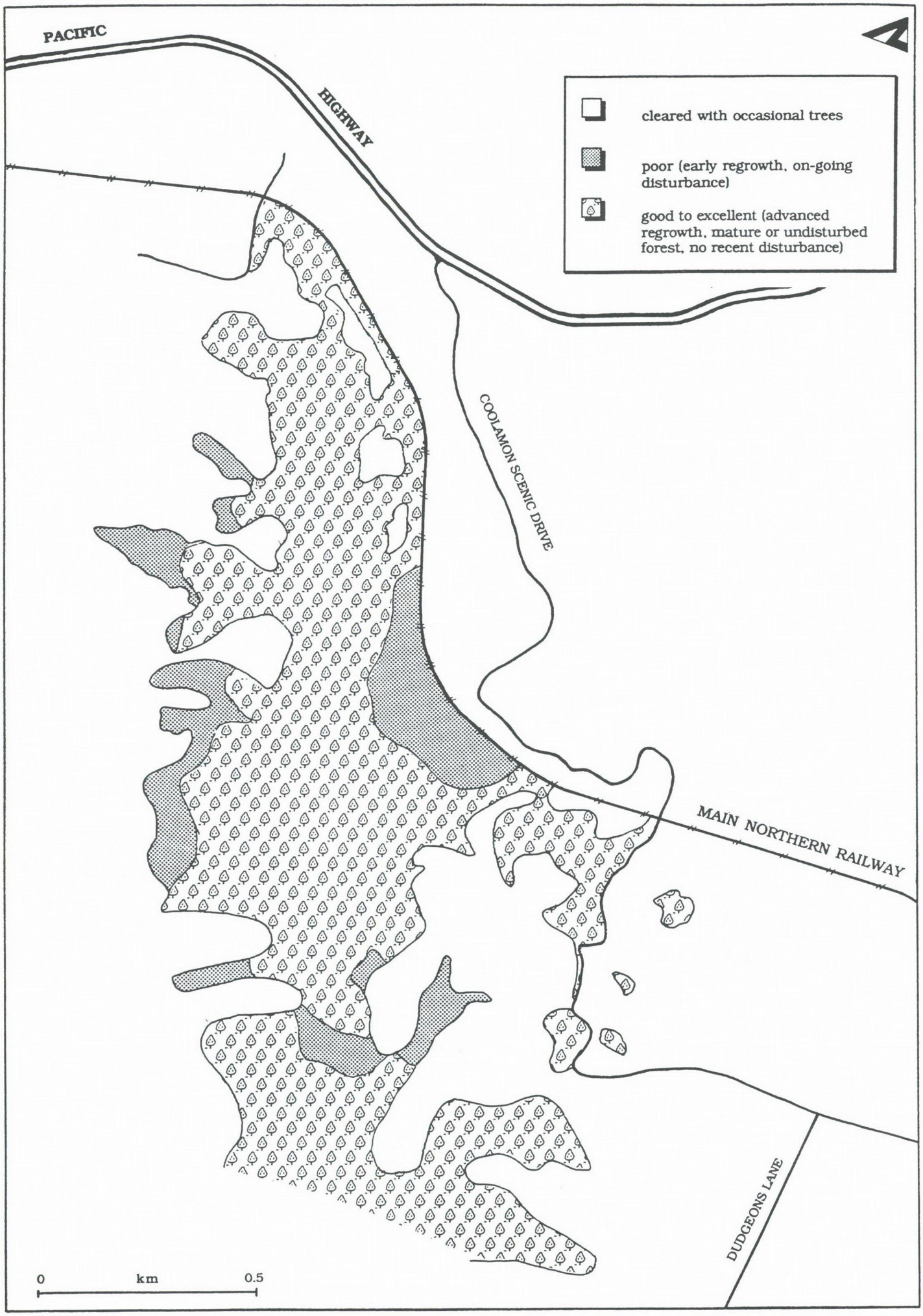

FIGURE D Vegetation condition on the Hillans Corner Ridge, north of Coolamon Scenic Drive.

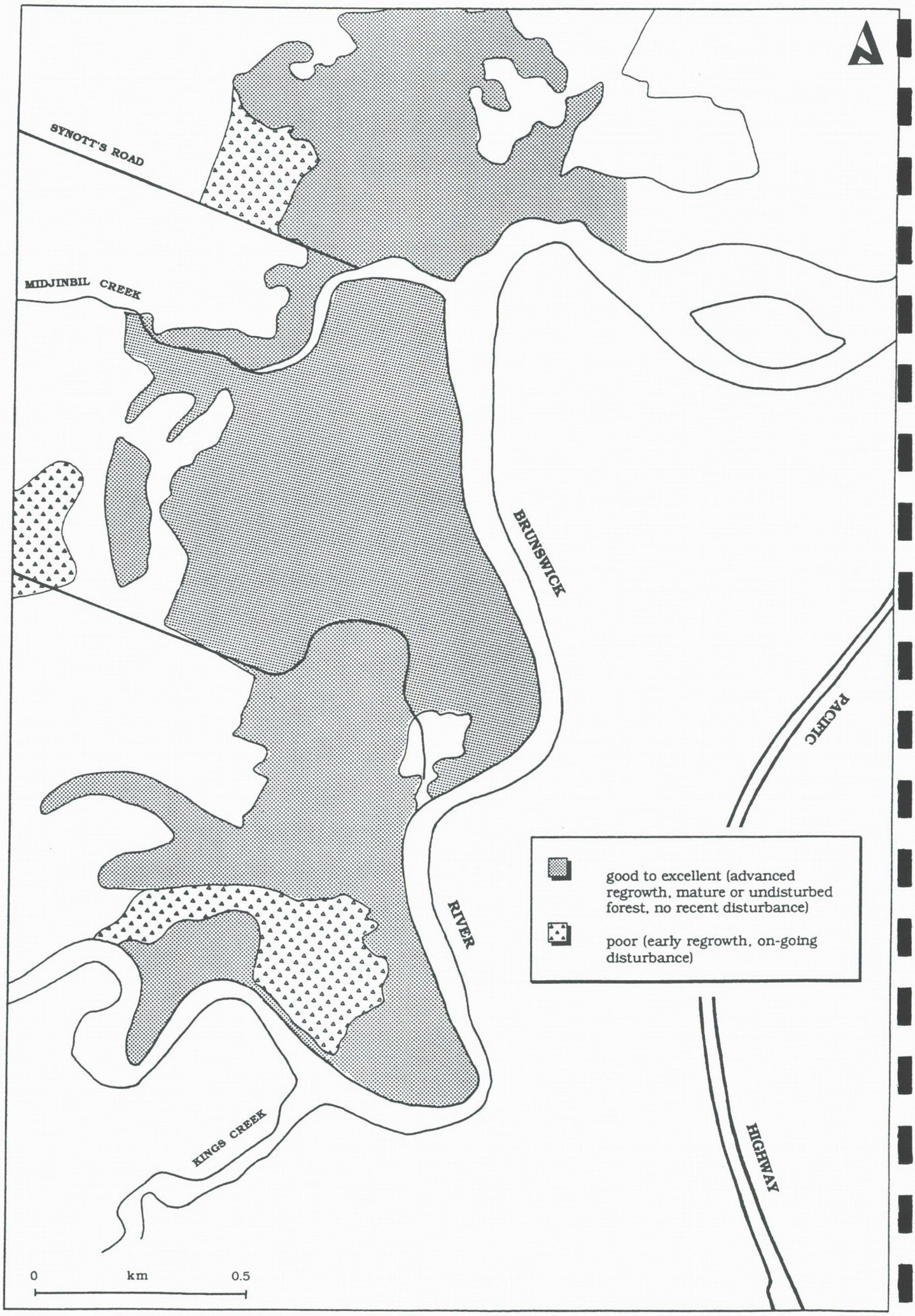

FIGURE E Condition of vegetation west of the Brunswick River in the vicinity of Coolamon Scenic Drive and Vallences Road.

Report to:

Sinclair Knight Merz

Proposed Pacific Highway Upgrade

Brunswick River to Yelgun

July 1998

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Introduction

The Ecology Lab Pty Ltd was requested by Sinclair Knight Merz to submit a literature review of the fish fauna of the drainages of the Brunswick River. In particular, information relating to threatened fish in the area that may be affected by the proposed Pacific Highway upgrade between Brunswick and Yelgun. This report deals with the fish fauna of the lower Brunswick River and Marshall Creek, the waterways potentially affected by the development. It also includes a preliminary Eight Point Test, as required under the Fisheries Management Amendment Act 1997, for any threatened species likely to be found in the area.

Description of the Study Area

The study area encompasses the proposed Pacific Highway route which crosses the Brunswick River upstream of Brunswick Heads and then heads generally north-northeast, crossing Marshalls Creek near Yelgun. A new bridge would be constructed over the Brunswick River downstream of the existing one.

Fish Communities

The freshwater fish fauna of New South Wales comprises 83 species in 33 families (Table 1, Faragher and Harris 1994), 58 of which potentially occur in drainages on the NSW far north coast. Seven of these species are introduced, while one (*Bidyanus bidyanus*, silver perch) is a translocated species, i.e. native to Australia but not the north coast. The proposed highway route also crosses estuarine reaches of the Brunswick River. Any attempt to describe the fish fauna of waterways along the route should therefore consider estuarine species.

Very few fish surveys have been done in this area. The Ecology Lab (1992) sampled Marshalls Creek to assess the impact of dredging. Dusky flathead (*Platycephalus fuscus*), sand whiting (*Sillago ciliata*), luderick (*Girella tricuspidata*) and three species of mullet (*Liza argentea, Mugil cephalus, Myxus petardi*) were caught by gillnet. It was suggested that other species of fish such as bass, eels, gudgeons and sunfish would be found in upper reaches of the creek. Dredging was strongly opposed by local fishers and NSW Fisheries due to the perceived value of the creek (which includes significant, relatively pristine mangrove, saltmarsh and seagrass habitats) as a nursery area for a large range of species. Dipnetting and seining of Lake Ainsworth (TEL 1996), slightly south of the study area, found only mosquito fish (*Gambusia holbrooki*) and firetailed gudgeon (*Hypseleotris galii*). No published information on the Brunswick River fish fauna was found, although the estuary supports a recreational fishery and there is an extensive offshore fishery based partly on prawns (which are dependent on the estuary) (TEL 1992). The estuarine fish fauna is probably similar to other estuaries in the region such as the Clarence and Richmond rivers (Table 2, also see West 1992, Harris and Gehrke 1997).

Species of Special Interest

Most of the fish listed in Tables 1 and 2 are widespread throughout river drainages of the far north coast. Some, however, require special mention because of their lifecycle requirements or status as threatened species.

Migratory species

Australian bass (*Macquaria novemaculeata*), freshwater herring (*Potamalosa richmondia*), striped mullet (*Mugil cephalus*) and freshwater mullet (*Myxus petardi*) are catadromous, migrating to the estuary to spawn, then returning to freshwater as juveniles and adults (Faragher and Harris 1994). These species require free passage along the river in order to complete their breeding cycle.

Threatened species

A number of freshwater species are regarded as threatened and are therefore protected by either State or Commonwealth legislation. There are various classifications under threatened, including: "endangered", taxa which have suffered a population decline over all or most of their range, whether the causes of this decline are known or not and which are in danger of extinction in the near future; and "vulnerable", taxa that are not presently endangered but which are at risk by having small populations and/or by occupying restricted habitats susceptible to rapid environmental change and/or populations which are declining at a rate that would render them endangered in the near future (Pollard *et al.* 1990).

Four species of fish have been have been declared as threatened species under new NSW Fisheries legislation, requiring that the fish and their habitats need special consideration in planning decisions (Smith and Pollard 1998). Three of these are found in the northern NSW – southern QLD region, potentially in waterways in the path of the highway extension, and are discussed below.

The Eastern Freshwater Cod (*Maccullochella ikei*) is listed as an "endangered" species under both the NSW Fisheries Management Act 1994 and the Commonwealth Endangered Species Protection Act 1992. It is totally protected by Fisheries legislation. Prior to 1988 it was found only in the upper reaches of the Clarence River system, but has since been stocked into the Richmond River. Although *M. ikei* has not been recorded from the Brunswick River or any part of the study area, it should be noted that its capture is prohibited in the eastern drainage system from the Macleay River to the QLD border (Rowland 1996).

The Oxleyan Pygmy Perch (*Nannoperca oxleyana*) is listed as "endangered" under the recently amended NSW Fisheries Management Act and as "vulnerable" under the Commonwealth Endangered Species Protection Act 1992. The species is recorded only from southeastern QLD and northern NSW. In NSW it is known from one lake in Bundjalung National Park south of the Richmond River, and has formerly been recorded at Coraki on the Richmond River and in Lake Hiawatha near Grafton (McDowall 1996, Smith and Pollard 1998). Its current status in these latter two areas is unknown. The potential range of the species does, however, encompass the areas proposed for the highway extension, although we were unable to obtain details of any other sites in NSW. *N. oxleyana* has been found only in streams, swampy areas and two lakes in coastal heathlands, usually in dense aquatic vegetation in slow moving or still, acidic waters (pH 5.4-5.7). The Oxleyan pygmy perch is threatened by habitat destruction, water pollution and the presence of *Gambusia* species (McDowall 1996).

The Honey Blue-eye (*Pseudomugil mellis*) is described as "vulnerable" under both NSW State and Commonwealth legislation schedules. This small species has a very restricted range, confined to south-eastern QLD, from Brisbane to Bundaberg (McDowall 1996, Merrick and

Schmida 1984), although Smith and Pollard (1998) suggest that it has previously been recorded from far northern NSW. Further investigation would be required to clarify distribution south of the QLD border. *P. mellis* may be affected by the highway proposal if it is found on the NSW north coast.

Other species

Three other freshwater species rate special mention due to their status according to the Australian Society for Fish Biology (ASFB). The first is the silver perch (*Bidyanus bidyanus*) whose natural distribution is restricted but is a common aquaculture species and has been stocked in northern NSW river drainages (Faragher and Harris 1994). This species is considered to be reduced in numbers but are not protected under NSW legislation (Smith and Pollard 1998). Fishing restrictions apply to silver perch and they can only be captured in the backed up waters of dams or reservoirs, i.e. areas where they have been stocked for recreational fishing purposes. Second, the eastern form of the freshwater catfish (*Tandanus tandanus*) occurs in the drainages of northern NSW. Recent genetic data on this species indicates that more than one species may exist (Jerry and Woodland 1997), resulting in a classification of "uncertain status" for the taxa (Faragher and Harris 1994, Smith and Pollard 1998). The third species is the southern purple-spotted gudgeon (*Mogurnda adspersa*) which is listed as "restricted" by ASFB (Faragher and Harris 1994). This species is found locally in coastal streams from northern NSW to northern QLD and is believed to have declined due to the presence of *Gambusia* sp. (McDowall 1996).

There are no threatened or protected estuarine fish species that are likely to be affected by the highway extension.

Fisheries Management Amendment Act 1997 – The "Eight Point Test"

The Eight Point Test is a series of questions, the answers to which assist in determining whether a planned action will significantly affect threatened species, populations or ecological communities or their habitats. Unless further evidence for the honey blue-eye occurring in northern NSW comes to light, the Oxleyan pygmy perch is the only threatened species that may be affected by the RTA proposal. Please note that no populations have been located in the Brunswick drainage, however, the potential range does include the study area. What follows is a preliminary eight point test based on our initial literature search. Due to the paucity of information on this species and the limited time frame of this desktop study, it is recommended that a more intensive literature search and/or field investigation is conducted during the determination period.

From our limited knowledge of the Oxleyan pygmy perch, the eight points (in italics) are addressed, in a preliminary sense, according to Schedule 1 of the Fisheries Management Amendment Act 1997:

(i) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.*

Habitat destruction and pollution (or reduced water quality) are major threats to this species. The proposed road design is such that all waterways will be bridged or culverts provided which will not impede flow or restrict fish passage, and will not result in destruction of habitat. The construction methods used include

sedimentation controls and other features which are designed to minimise impacts on water quality in the adjacent creeks and waterways.

(ii) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*
There are no endangered populations listed on the schedules of the Fisheries Management Amendment Act 1997.

(iii) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*
There are no threatened populations or ecological communities on the schedules of the Fisheries Management Amendment Act 1997.
For the Oxleyan Pygmy Perch, a "significant area of known habitat" will not be modified or removed. The road design is such that the habitat of this species, if it is found in the area of the proposed road, would be unaffected. The road design features and runoff controls discussed earlier will be in place to minimise any potential impact on habitat.

(iv) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.*
Populations of the Oxleyan Pygmy Perch are small, scattered and not well documented. However, should any populations of this species be found in the area, they will not be affected because the proposed road design will not impede flow or restrict fish passage (all waterways will be bridged or culverts provided).

(v) *Whether critical habitat will be affected.*
There are no critical habitats listed on the schedules of the Fisheries Management Amendment Act 1997.

(vi) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*
This species in not represented in conservation reserves or any similar protected areas within NSW. The range of the Oxleyan Pygmy Perch includes a lake in Bundjalung National Park (northern NSW), but this area is not designed to protect fish.

(vii) *Whether the action proposed is of a class of action that is recognised as a threatening process.*
The proposed action is not classed as threatening under the Fisheries Management Amendment Act 1997.

(viii) *Whether any threatened species or ecological community is at the limit of its known distribution.*
The Oxleyan Pygmy Perch has a very restricted range in southern Queensland and northern NSW. In the area of the proposed roadworks it is considered to be at the limit of its known distribution.

References Cited

Faragher, R.A. and Harris, J.H. (1994). The Historical and Current Status of Freshwater Fish in New South Wales. *Australian Zoologist* **29 (3-4)**, pp. 166-176.

Harris, J.H. and Gehrke, P.C. (1997). *Fish & Rivers in Stress: The NSW Rivers Survey*. NSWFisheries, Cronulla, NSW, 1-298 pp.

Jerry, D.R. and Woodland, D.J. (1997). Electrophoretic Evidence for the Presence of the Undescribed 'Bellinger' Catfish (*Tandanus* Sp.) (Teleostei: Plotosidae) in Four New South Wales Mid-Northern Coastal Rivers. *Marine & Freshwater Research* **48**, pp. 235-240.

McDowall, R. M. (1996). *Freshwater Fishes of South-Eastern Australia*. South China Printing, HK.

Merrick, J.R. and Schmida, G.E. (1984). *Australian Freshwater Fishes – Biology and Management*. Griffin Press, Australia.

Pollard, D.A., Ingram, B.A., Harris, J.H., and Reynolds, L.F. (1990). Threatened Fishes in Australia - an Overview. *Journal of Fish Biology* **37**, pp. 67-78.

Rowland, S.J. (1996). Threatened Fishes of the World: *Maccullochella ikei* Rowland, 1985 (Percichthyidae). *Environmental Biology of Fishes* **46**, pp. 350-350.

Smith, A.K. and Pollard, D.A. (1998). Policy and Guidelines – Aquatic Management and Fish Conservation 1998. NSW Fisheries, Sydney.

The Ecology Lab Pty Ltd (1996). *Lake Ainsworth Processes Study - Flora and Fauna*, Prepared for: Manly Hydraulics Lab.

The Ecology Lab Pty Ltd (1992). *Marshalls Creek Dredging Investigation: Stage 1 Report. Marine Ecological Studies*, Prepared for: Planning Workshop.

West, R. (1992). *Summary of Major Research Findings From the Northern Rivers Fisheries Project (Draft)*, Internal publication of the FRI.

Table 1: Representation of fishes in New South Wales North coast fresh waters (after Faragher and Harris, 1994).

Family	Species
Ambassidae	*Ambassis agassizi*
	Ambassis nigripinnis
Anguillidae	*Anguilla australis*
	Anguilla reinhardtii
Apogonidae	*Glossamia aprion*
Ariidae	*Arius graffei*
Atherinidae	*Atherinosoma microstoma*
	Craterocephalus marjoriae
	Craterocephalus stercusmuscarum
Belonidae	*Strongylura krefftii*
Chanidae	*Chanos chanos*
Clupeidae	*Nematalosa erebi*
	Potamalosa richmondia
Cyprinidae	*Carissius auratus*
	Cyprinus carpio
Eleotridae	*Butis butis*
	Gobiomorphus australis
	Gobiomorphus coxii
	Hypseleotris compressa
	Hypseleotris klunzingeri
	Hypseleotris sp 2
	Mogurnda adspersa
	Philypnodon grandiceps
	Philypnodon sp1
Gadopsidae	*Gadopsis marmoratus*
Galaxiidae	*Galaxias maculatus*
	Galaxias olidus
Gobiidae	*Arenigobius bifrenatus*
	Pseudogobius olorum
	Redigobius macrostoma
Hemihamphidae	*Arramphus sclerolepis*
Kuhliidae	*Nannoperperca oxleyana*
Lutjanidae	*Lutjanus argentimaculatus*
Megalopidae	*Megalops cyprinoides*
Melanotaeniidae	*Melanotaenia duboulayi*
	Pseudomugil signifer
	Rhadinocentrus ornatus
Monodactylidae	*Monodactylus argenteus*
Mugilidae	*Liza argentea*
	Mugil cephalus
	Myxus elongatus
	Myxus petardi
	Valamugil georgii
Percichthyidae	*Maccullochella ikei*
	Macquaria ambigua
	Macquaria colonorum
	Macquaria novemaculeata

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Table 2: Fish species recorded in the Richmond River and Clarence drainage basins in the NSW Rivers Survey (after Harris and Gehrke, 1997).

Family	Species
Ambassidae	*Ambassis agassizi*
	Ambassis nigripinnis
Anguillidae	*Anguilla australis*
	Anguilla reinhardtii
Ariidae	*Arius graffei*
Atherinidae	*Craterocephalus fluviatilis*
	Craterocephalus marjoriae
Carangidae	*Gnathanodon speciosus*
Carcharhinidae	*Charcharhinus leucas*
Clupeidae	*Herklotsichthys castelnaui*
	Potamalosa richmondia
Cyprinidae	*Carissius auratus*
Eleotridae	*Gobiomorphus australis*
	Gobiomorphus coxii
	Hypseleotris compressa
	Hypseleotris galii
	Hypseleotris spp
	Philypnodon grandiceps
	Philypnodon sp
Galaxiidae	*Galaxias maculatus*
	Galaxias olidus
Hemirhamphidae	*Arramphus sclerolepis*
Kuhliidae	*Nannoperperca oxleyana*
Melanotaeniidae	*Melanotaenia duboulayi*
	Pseudomugil signifer
	Rhadinocentrus ornatus
Mugilidae	*Liza argentea*
	Mugil cephalus
	Myxus petardi
Percichthyidae	*Maccullochella ikei*
	Macquaria colonorum
	Macquaria novemaculeata
Platycehalidae	*Platycephalus fuscus*
Plotosidae	*Tandanus tandanus*
Poeciliidae	*Gambusia holbrooki*
Retropinnidae	*Retropinna semoni*
Scorpaenidae	*Nothesthes robusta*
Sparidae	*Acanthopagrus australis*
Terapontidae	*Leiopotherapon unicolor*