Roads and Traffic Authority

Pacific Highway Upgrade - Oxley Highway to Kempsey

Flora and Fauna Working Paper

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Appendix I

Part 3A assessments of significance

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

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

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

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

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

Threatened flora species and EECs considered for this assessment are:

- *Acronychia littoralis* (scented acronychia)
- *Arthraxon hispidus* (hairy jointgrass)
- *Melaleuca biconvexa* (biconvex paperbark)
- *Maundia triglochinoides* (maundia)
- *Parsonsia dorrigoensis* (milky sikpod)
- *Phaius australis* (southern swamp orchid)
- *Phaius tancarvilleae* (swamp orchid)
- Swamp Sclerophyll Forest
- Swamp Oak Floodplain Forest
- Subtropical Coastal Floodplain Forest
- Freshwater Wetlands

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

No threatened flora were recorded during the field surveys, however, as a precautionary measure an assessment of the possible impact of the Proposal on the above seven threatened flora species has been undertaken.

Breeding cycles of threatened flora would only be significantly disrupted locally if most or all individuals of a population were removed or the population seriously fragmented. It is considered unlikely that any population of threatened flora would be removed or fragmented by the Proposal.

The Proposal is considered unlikely to directly displace or disturb threatened flora species that were not detected during the surveys, but could nevertheless be present in small numbers in highly restricted parts of the study area. However, a small chance remains that individuals of any of these subject species could be directly removed by the Proposal. In all cases, if this were to occur, the loss would be insignificant in relation to the regional distribution of the species and would not place the species at risk of extinction.

It is possible that runoff from the Proposal during both construction and operation could indirectly affect threatened species associated with swamp habitats such as maundia, biconvex paperbark, swamp orchid and southern swamp orchid (if present). It is expected that the mitigation measures for control and management of runoff, including sediment and pollution would effectively prevent any significant indirect disturbances.

Other species that would not be directly impacted could be indirectly affected by edge effects and associated weed invasions. Such species could include hairy jointgrass and milky sikpod. One nearby record of hairy jointgrass occurs within 2 kilometres to the west of the Proposal in the Kundabung area (see Appendix A.1) but the species could occur closer to the alignment. In this case, mitigation measures for control and management of weeds would effectively address and ameliorate these possible impacts. Further details of suggested management and amelioration measures are given in the Recommendations (Section 6).

Breeding cycles of threatened flora populations in the study area would only be significantly disrupted if most or all individuals of the population were removed or the population seriously fragmented.

Since no threatened flora species were recorded in the study area during field surveys, it is considered unlikely that the Proposal would disturb any seedbanks of threatened flora. Impacts on seedbanks of threatened flora species by the Proposal are considered to be unlikely. For the same reason, impacts on pollen cycles of other threatened flora species are considered unlikely.

None of the threatened flora species that could occur in the study area have dormancy period mechanisms likely to be significantly disturbed by the Proposal.

No draft or final Recovery Plans for any of the subject flora species are currently available.

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

Threatened flora species

Populations of scented acronychia are highly vulnerable to invasions of introduced weeds, particularly lantana, bitou bush and exotic vines (DECC 2008). Invasions of all these species or species groups are listed as key threatening processes on the TSC Act. Lantana (*Lantana camara*) is also listed as a notifiable noxious weed under the Noxious Weeds Act. Lantana was abundant in patches within the study area, and localised infestations of the exotic vines moth plant (*Araujia sericifera*), morning glory and mile-a-minute (*Ipomoea indica* and *I. cairica*) were present. Bitou bush (*Chrysanthemoides monilifera*) was not recorded within the study area, however it could invade.

Disturbances associated with the Proposal could initiate conditions that facilitate invasions of exotic species. Significant weed invasions would also have the potential to degrade the habitat for endangered ecological communities, and threatened or significant flora species if present.

Runoff of sediment, nutrients and pollutants could directly impact on the habitat threatened species during both the construction and operation phases of the Proposal. Runoff of nutrients could also indirectly initiate a process of weed invasion as discussed above.

Targeted management and control of runoff as well as direct control of noxious and environmental weeds should be an integral part of the Proposal, during both the construction and operation phases.

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

Endangered ecological communities

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

- Swamp Sclerophyll Forest on Coastal Floodplains (19.9 hectares).
- Subtropical Coastal Floodplain Forest (11.7 hectares).
- Freshwater Wetlands (3.8 hectares).
- Swamp Oak Floodplain Forest (0.9 hectares).

The total impact on EECs represents 12.8 per cent of the area of natural vegetation within the Proposal footprint. Apart from a degree of fragmentation of habitat for Swamp Sclerophyll Forest on Coastal Floodplains in Cairncross State Forest (as discussed below in part (e)), the effect on the total area of habitats for all EECs locally would be minor and limited to localised losses of habitat from larger areas of communities that would remain extant locally.

In order to place the extent of each EEC that would be impacted by the Proposal into a regional context, data from the vegetation mapping of the Comprehensive Regional Assessment of north eastern NSW (NPWS 1999) was consulted. The area covered by this regional study broadly corresponds to the North Coast Bioregion of Thackway & Creswell (1995). This area is defined as the region for the purposes of this assessment. The relevant map units from the regional study that are included within each EEC according to the relevant Final Determinations, together with their remaining area as of 1999 and conservation status within the region are given in the table below.

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

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

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

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

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

EEC	Total Extent of EEC in Region (NPWS 1999) (ha)	Area of EEC Impacted by Proposal (ha)	Percentage of EEC Impacted in Region
Swamp Sclerophyll Forest	29155	19.9 ha	0.07%
Swamp Oak Floodplain Forest	28833	0.9 ha	0.003%
Subtropical Coastal Floodplain Forest	60018	11.7 ha	0.02%
Freshwater Wetlands	24118	3.8 ha	0.02%

As the table shows, no more than 0.1 per cent of the total area of any EEC in the region would be removed or modified by the Proposal. The total area of each EEC indirectly affected by runoff, weed invasion and other degrading processes may slightly increase these proportions, but not to the extent that a significant proportion of each EEC would be affected regionally.

Runoff of sediment, nutrients and pollutants could directly impact on the habitat of both ecological communities and threatened species during both the construction and operation phases of the project. Runoff of nutrients could also indirectly initiate a process of weed invasion as discussed above.

Targeted management and control of runoff as well as direct control of noxious and environmental weeds should be an integral part of the Proposal, during both the construction and operation phases.

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

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

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

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

Biconvex paperbark has been recorded along the NSW coast from Jervis Bay in the south, to just south of Port Macquarie in the north, according to the BioNet database and the report for the Oxley Highway deviation (BIOSIS Research 2004). The species, if present in the study area, would therefore be at or beyond the northern limit of its currently known distribution.

Maundia has been recorded along the NSW coast from Botany Bay in the south to far northern NSW in the north. It also occurs in Queensland. The species, if present in the study area, would therefore not be at the limit of its currently known distribution.

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

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

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

Therefore there is a chance that the Proposal could affect four species (scented acronychia, hairy Jointgrass, swamp orchid and southern swamp orchid) at or near the southern limit of their known distributions and one species at the northern limit of its known distribution (biconvex paperbark).

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

A large proportion of the study area is currently highly disturbed and modified by farming, grazing, plantations, quarries, tracks and roadside disturbances. Some of these disturbed areas will be permanently removed by the Proposal. The Proposal has the potential to impose physical disturbance on areas that were previously undisturbed, particularly in areas that currently support natural vegetation. These effects can be minimised by current best practice ameliorative measures such as soil stabilisation and control of runoff, and revegetation of newly created bare areas used for construction or stockpile purposes.

The current intensity and frequency of fire is not likely to be significantly affected by the Proposal.

Flooding flows are unlikely to be affected to a significant degree provided adequate provision is made to allow for natural movement of floodwater across the upgraded highway alignment in the form of bridges, culverts, drains etc.

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

The Proposal is expected to result in the removal of strips of remnant vegetation of varying length from within the study area, including the removal of vegetation from within mapped areas of key habitat and wildlife corridors.

This will have some implications for natural vegetation communities, including endangered ecological communities and could have implications for at least one and possibly more threatened flora species.

South of the Wilson River, the proposed route deviates from the existing highway alignment and traverses the north-east section of Cairncross State Forest. The proposed route would reduce and fragment two areas of vegetation identified as the endangered ecological community Swamp Sclerophyll Forest on Coastal Floodplains. This would physically separate two narrow sections of the EEC between the existing highway and the proposed route. However, the ecosystems would not be completely separated functionally and would continue to interact in terms of transfer of pollen, seed, propagules and other means of genetic dispersal and exchange.

In summary, it is considered that the Proposal would contribute to general fragmentation of natural vegetation, including at least one EEC. However, the remaining areas of natural vegetation on either side of the deviation through Cairncross State Forest are considered large enough to continue as functioning ecosystems. Exchange of genetic material is still likely to occur between the separate patches across the highway by means of insect, wind and water borne dispersal of pollen, seeds and propagules. Such dispersal mechanisms could be facilitated by retention or planting of some vegetation in the median strip between the two carriageways, to the extent that this does not compromise traffic safety.

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

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

Conclusion to Part 3A Assessment for threatened flora and EECs

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

- No threatened flora were recorded within the Proposal footprint.
- It is unlikely that the Proposal would fragment populations of threatened flora.
- Less than 0.1 per cent of the total area of any EEC in the Mid-North Coast Region of NSW would be removed or modified by the Proposal. Clearing for the Proposal would not be to the extent that a significant proportion of each EEC would be affected regionally.
- Although the Proposal would contribute to general fragmentation of natural vegetation, including at least one EEC, the remaining areas of natural vegetation on either side of the deviation through Cairncross State Forest are considered large enough to continue as functioning ecosystems.

Appendix I.2 Assessment of impact on threatened fauna

This assessment addresses the potential effects of the Proposal on threatened fauna species or their habitats according to Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* under Part 3A of the Environmental Planning and Assessment Act 1979 (DEC & DPI 2005). Threatened fauna species known or with potential to occur within the study area are listed below. Those species positively identified during surveys within the study area are marked with an asterix*.

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

In addition to these threatened fauna species, the Director-General's requirements explicitly require that possible impacts on *Saproscincus oriarus* be included in the assessment. However according to supplementary advice from DECCW, unless records of this species were found to exist within the study locality or the species was recorded in the field, no further assessment for this species is required.

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

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

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

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

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

This species was not recorded during field survey work, though it may occur or occasionally visit the study area. The Proposal is expected to result in the removal of potential foraging habitat for the barred cuckoo-shrike, which would reduce the amount of foraging habitat available to the barred cuckoo-shrike within the locality. However the Proposal is not expected to displace a local population of this species.

The Proposal is also considered unlikely to disrupt the breeding cycle of the barred cuckoo-shrike though there is a slim possibility that a nest site may occur in the area to be cleared. If that is the case, then the Proposal could result in a disruption to that season's breeding cycle for the pair involved.

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

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

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

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

Given the large home range, small population sizes and the reproductive strategy of male die-off, this species is considered to be particularly vulnerable to fragmentation of suitable habitats and local extinctions. Widespread logging and activities resulting in the loss of actual and potential nest hollows are also a significant threat to this species, as are activities that open up habitat to allow access by introduced predators. The brush-tailed phascogale is vulnerable to road mortality, particularly males during the breeding season or during juvenile dispersal in late spring or early summer.

The brush-tailed phascogale was not recorded within the study area during field survey work though a number of records occur within 2 kilometres. Given the difficulties in surveying for this species, it is considered likely to occur in larger tracts of bushland within the study area, including Maria State Forest and possibly Rawdon Creek Nature Reserve and Cairncross State Forest.

The Proposal is likely to result in the loss of a long strip of potential foraging habitat for the brush-tailed phascogale and would also result in the loss of a large number of potential roosting and breeding hollows. The widening of the road corridor is also likely to increase the risk of road death for this species. Given the large home range of the brush-tailed phascogale, where the proposed alignment deviates from the existing highway through currently contiguous native vegetation, this could cut through an individual phascogale's territory, exposing it to greater risk of road death and predation as it would be forced to cross the new highway to move between foraging areas or roost hollows.

The Proposal is likely to result in the disturbance of this species and could potentially displace the brush-tailed phascogale from some areas. Clearing associated with the Proposal would result in the loss of potential foraging habitat and roost hollows, and in areas where the proposed route deviates through Cairncross State Forest, the opening up of habitat which may make it more accessible to feral cats and foxes, thus increasing the risk of predation for the brush-tailed phascogale. The proposed deviation of the road route through this area would further fragment potential habitat for the brush-tailed phascogale and could potentially displace individuals from existing territories. The proposed widening of the road corridor could also result in an increased risk of death by vehicle strike.

There is a possibility that the Proposal may disrupt the breeding cycle of the brush-tailed phascogale, particularly if a hollow tree or log containing a pregnant female or female with young is removed. If this occurs in a relatively isolated patch of bushland, the area may not be recolonised.

In summary, potential impacts associated with the Proposal include the loss of potential roosting and breeding hollows, the loss of potential foraging habitat and the further fragmentation of habitat. As a result of these disturbances, it is considered that the Proposal could potentially affect the life-cycle of the brush-tailed phascogale.

Ameliorative measures such as aerial rope crossings and underpasses may assist in maintaining habitat connectivity for the brush-tailed phascogale. Supplementary plantings, rehabilitation of currently cleared or degraded habitat and provision of habitat offset may also assist in mitigating long-term impacts on the brush-tailed phascogale. Of particular importance to this species is the maintenance and rehabilitation of fauna movement corridors.

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

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

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

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

The little bent-wing bat was one of the most commonly recorded species, being found at seven of the eight base survey sites and five supplementary sites during Ecotone field work within the study area. The little bent-wing bat was also recorded during supplementary surveys by GHD in November 2007. While maternity caves are known in the Yessabah and Willi Willi Caves west of Kempsey, this species is unlikely to breed in roost sites near to the highway route. Small numbers of this species may seasonally roost under bridges and culverts along the existing road route, with a few individuals noted to roost in the girder gaps of the southbound Maria River road bridge.

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

The eastern bent-wing bat was recorded at five of the eight base survey sites and four supplementary sites during Ecotone fieldwork within the study area. The eastern bent-wing bat was also recorded during supplementary surveys by GHD in November 2007. Maternity caves are known in the Yessabah Caves west of Kempsey, though this species is unlikely to breed in roost sites near to the highway route. Small numbers of this species may seasonally roost under bridges and culverts along the existing road route.

The large-eared pied bat was not recorded during field surveys however potential habitat occurs in the vicinity of the Cooperabung Range and individuals may roost under bridges and culverts in the study area.

Although known foraging habitat would be cleared or modified as a result of the Proposal, it is unlikely that the eastern bent-wing bat would be disadvantaged to a significant degree as individuals are often recorded in open and even urban habitats. The clearing of native vegetation is likely to have a greater impact on the little bent-wing bat as this species forages below the canopy.

No suitable breeding habitat for any of these species occurs within the study area and none is expected to be impacted as a result of the Proposal. However as these species may utilise bridges and culverts within the study area for roosting on a seasonal or occasional basis, there is potential for individuals of both species to be killed if a bridge or culvert containing roosting bats is destroyed or removed. In addition, increased traffic volumes and vehicle speeds along the highway could result in an increase in the number of road deaths.

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

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

The common planigale was not recorded within the study area during Ecotone surveys and only one record exists within 2 kilometres of the study area. However, given the difficulties of surveying for this species, it has potential to occur in forested areas within the study area, particularly those areas near watercourses, drainage lines and swampy areas. The main potential impacts associated with the Proposal are expected to be the further fragmentation of habitat and possible disturbance to potential habitat surrounding waterbodies within the study area.

The Proposal is likely to result in the loss of a long strip of potential habitat for the common planigale within the study area. This has potential to displace the common planigale in some areas, particularly where the proposed route deviates through currently intact vegetation in Cairncross State Forest. The Proposal may also disrupt the breeding cycle of the common planigale as it could result in the removal of nest sites under vegetation, bark and logs. While it is unknown what impact this would have on the overall population, the removal of potential breeding habitat associated with the Proposal could result in the loss of individuals, including breeding females that may currently reside within the road corridor.

In addition, the Proposal may increase the risk of road death for common planigales and make it more vulnerable to predators. While the existing highway would already pose a barrier to the dispersal ability of the common planigale, the widening of the road corridor is likely to make dispersal across the highway more difficult.

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

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

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

The eastern chestnut mouse was not recorded during the field survey although some potentially suitable habitat does occur. Suitable habitat for the eastern chestnut mouse within the study area includes swampy areas, particularly those with a dense understorey. As the Proposal will result in the loss of areas of swamp forest from within the study area, this could potentially impact eastern chestnut mouse habitat. This is particularly the case where the proposed new highway route deviates from the current alignment and through a section of Cairncross State Forest. A large area

of swamp forest containing potential habitat for the eastern chestnut mouse is expected to be removed in this area and if a local population occurs, this could result in the species being displaced from the area. The removal of this vegetation and widening of the road corridor is also likely to further fragment habitat for the eastern chestnut mouse, making movement between patches of habitat more difficult and increasing the risk of road death. In addition, there is a small chance that vegetation clearing associated with the Proposal may disrupt the breeding cycle of the eastern chestnut mouse, as it may result in direct deaths or loss of habitat for a family group.

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

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

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

The barking owl was not recorded during field survey work, though some suitable habitat does occur. The barking owl prefers heavily forested areas and is more likely to inhabit larger tracts of bushland, including Cairncross, Ballengarra and Maria River State Forests and Rawdon Creek and Cooperabung Creek Nature Reserves.

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

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

While a long strip of potential foraging habitat is expected to be removed as a result of the Proposal, given the large home ranges of all of these species, this is unlikely to displace a population of any of these four threatened owl species. However increased light and machinery noise at night during the construction phase may cause owls to avoid construction areas and forage further away.

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

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

A recovery plan for the powerful owl, sooty owl and masked owl (DEC 2006b) and a draft recovery plan for the barking owl (NPWS 2003b) have been prepared. The Proposal is considered inconsistent with these plans as it is expected to result in the loss of potential foraging and breeding habitat for these species.

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

All three species are rainforest species and forage on a variety of fruit bearing trees, shrubs and vines. While their distribution includes coastal NSW, all three species are more commonly found in northern Australia. None of these species were recorded during Ecotone field survey work however the rose-crowned fruit-dove was tentatively identified during supplementary surveys by GHD in November 2007. All three species have some potential to opportunistically visit areas within the study area that exhibit rainforest elements.

Five hectares of moist floodplain closed forest with rainforest elements (Community 1) is expected to be removed as a result of the Proposal. Given that all three species are likely to be only opportunistic visitors to the study area, it is considered highly unlikely that the lifecycle of any of these three fruit-dove species will be greatly affected by the Proposal.

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

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

The stuttering frog was not recorded during field survey work however suitable potential habitat does occur in streams, rainforest and areas of tall moist forest within the study area. The giant barred frog was recorded at Maria River where two individuals were observed near the existing northbound bridge during the summer survey period in February 2007. Previous and subsequent visits to the bridge for bridge construction work recorded single specimens of the species, indicating that a resident population occurs. Suitable habitat for the giant barred frog occurs at the major freshwater creeks, particularly Barrys Creek, Smiths Creek, Pipers Creek and Yarrabee Road, though only the more common great barred frog *Mixophyes fasciolatus* was recorded at Site 6 (Barrys Creek), Site 5 (Yarrabee Road) and Site 7 (Maria River SF).

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

In order to minimise impacts upon these species, ameliorative measures to protect water quality and riparian vegetation cover (including leaf litter) will need to be put in place during bridge construction at these locations, although the creek at the Yarrabee Road site is outside of the Proposal footprint. Ideally, in order to facilitate fauna movement along riparian corridors, sufficient room should be left under each bridge to allow for a continuous vegetated bank along either side of the waterway.

During flora and fauna assessment fieldwork conducted in April 2006 for the RTA bridge widening at Maria River, the giant barred frog was recorded (Ecotone 2006a). Construction works on the Maria River bridge are currently being undertaken and various mitigation measures have been put in place to mitigate impacts on the giant barred frog. Such measures include frog fencing, water quality controls, silt fencing and spill booms. We have been informed by GHD that a monitoring program is in place at the site and site inspection and audits conducted by DECCW indicate that the measures have been successfully implemented and are functioning as required. As the Proposal would essentially involve a duplication of the bridge that is currently under construction, it is considered that provided adequate mitigation and management measures are developed at the detailed design stage, in consultation with the relevant authorities, and are of standard similar to or better than the measures currently in place at the Maria River site, the life cycle of the giant barred frog population is unlikely to be adversely affected by the Proposal.

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

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

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

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

The glossy black cockatoo occupies forests of south-eastern Australia, from Shoalwater Bay in central Queensland to the Victorian border region. Preferred habitat for this species generally consists of moist and dry eucalypt forest types with a she-oak understorey. In areas where she-oaks are abundant, this species is sedentary, however, in other areas glossy black cockatoos can be nomadic, moving from one food source to another (DECCW threatened species profile)

The breeding season is between March and August with eggs usually being laid between April and June. The nests are located in large hollow limbs or trunks, often in tall dead trees standing in clearings. The nests are usually between 13 and 22 metres above the ground. The glossy black-cockatoo relies almost entirely on the seeds of a few species of she-oak for food and any factor that reduces the quantity, quality or availability of the seed crop of these trees must have a direct impact on local populations, through starvation or reduced fecundity (DECCW threatened species profile).

The glossy black-cockatoo was not recorded within the study area during Ecotone surveys however it was recorded feeding in black she-oaks within Ballengarra State Forest during supplementary surveys by GHD in November 2007 (GHD 2007a). Evidence of recent feeding by the glossy black-cockatoo was also recorded by GHD approximately 50 metres south of Sancrox Road and several records of the species occur in forested areas along the existing highway within the study area. The main potential impacts associated with the Proposal include the loss of potential nest trees (those containing large hollows) and the loss of potential foraging habitat.

The Proposal is expected to result in the loss of a long strip of potential foraging habitat for the glossy black-cockatoo. While this is not expected to greatly affect the life-cycle of the glossy black-cockatoo in the short term, it would contribute to the cumulative loss of habitat affecting this species. The Proposal is also expected to result in the loss of a large number of hollow-bearing trees, including those containing potentially suitable nest hollows for the glossy black-cockatoo. While no nest trees were recorded within the study area during field survey work, the loss of a nest hollow could potentially disrupt the breeding cycle of the glossy black-cockatoo, particularly if it is removed during the breeding season.

Golden-tipped bat (*Kerivoula papuensis*) – vulnerable under the NSW TSC Act

The golden-tipped bat has been recorded in a narrow band in coastal areas and the sub-coastal slopes and ranges from Cape York Peninsula in Queensland south to the New South Wales/ Victorian border. Moist closed lowland forest appears to provide the most favoured habitat type for this species (Woodside 1995). The majority of captures of the golden-tipped bat have been made in coastal forests, near to where wet and dry forest ecotones occur, and often in the vicinity or over creeks. The species is known to occur in areas where dense or tangled vegetation is present, and along creeks, suggesting that the flight habits are suited to foraging in dense vegetation and in ecotonal habitats.

It is expected that this species feeds by gleaning, flying slowly in dense vegetation, and hovering to collect insects and spiders from vegetation or out of webs while on the wing (Schulz 2000). Golden-tipped bats have been located roosting in abandoned gerygone and scrubwren nests. These are dome-shaped nests made of bark fibre, moss and lichen and hang from vines and twigs (Churchill 1998). Little is known of the reproductive biology of this species in Australia, though it is considered likely that in southern Australia the golden-tipped bat breeds in early spring (Woodside 1995).

The golden-tipped bat was not recorded during field survey work however suitable potential habitat does occur in areas of rainforest and adjacent sclerophyll forest within the study area. The Proposal is likely to result in the loss of potential foraging, roosting and breeding habitat for the golden-tipped bat. Much of this potential habitat is degraded and not considered ideal for the golden-tipped bat, however the loss of these areas does contribute to the cumulative loss of habitat affecting this species. In the event that a population of the golden-tipped bat does occur in any of the areas to be cleared, the loss of that habitat could displace or result in the loss of that population, particularly if a breeding colony is destroyed.

Grass owl (*Tyto capensis*) – vulnerable under the NSW TSC Act

The grass owl occurs in all mainland states of Australia and in NSW is more common in the north-east. This ground-dwelling owl species inhabits areas of tall grass on grassy plains, swampy areas and floodplains. It rests by day and also nests on a trampled platform hidden in dense tall grass or sedges (DECCW threatened species profile)

The grass owl was not recorded during field survey work however potential suitable habitat does occur in areas of grassland on the Hastings River and Wilson River floodplains. As the proposed route travels through this area, potential habitat for the grass owl would be lost as a result of the Proposal. While this is unlikely to displace a local population of the grass owl, it would contribute to the incremental loss of habitat affecting this species. In the unlikely event that a nest containing eggs or chicks were to be destroyed during clearing or construction activities, this would disrupt the breeding cycle and could potentially adversely affect the local population.

Green and golden bell frog (*Litoria aurea*) – endangered under the NSW TSC Act and vulnerable under the Commonwealth EPBC Act.

The green and golden bell frog was once a common species in coastal New South Wales, where it inhabited vegetated dams and reed beds in rivers, swamps and lakes. The range of this species extended almost continuously from the far north coast of New South Wales to the east Gippsland district of eastern Victoria, and inland to 800 metres on the southern tablelands. By the early 1980's, this species had undergone a dramatic population decline, becoming scarce and possibly extinct in the tablelands and Australian Capital Territory, and populations in coastal areas were reduced and isolated. Habitat destruction, predation by the introduced mosquito fish (*Gambusia holbrooki*) and possibly a fungal infection (Chytridiomycosis) have been implicated in the rapid decline of this species (Pyke & Osborne 1996).

The green and golden bell frog is semi-aquatic, and does not undertake regular seasonal migrations away from the edges of waterbodies, although terrestrial movements have been reported, presumably in search of new breeding sites. This species utilises a range of habitats including slow-moving or still, permanent and semi-permanent ponds, lakes, creeks, swamps and farm dams. Most breeding records have been located within still, vegetated (especially by *Typha* sp) ephemeral ponds, which are unshaded and free of predatory fish (especially mosquito fish). Males call while floating in water, from August through to January, although they have been heard at other times. The green and golden bell frog is active during both the day and night.

The green and golden bell frog was not recorded during field survey work and given the lack of nearby records and the pattern of decline for this species, it is considered unlikely to occur. However as suitable potential habitat exists at dams and other waterbodies within the study area, it cannot be discounted. The Proposal is considered unlikely to affect the lifecycle of the green and golden bell frog, however if a population does occur at one of the dams along the proposed alignment, then the loss of that dam would result in the loss of that local population.

A draft recovery plan for the green and golden bell frog has been prepared (DEC 2005). While the Proposal is likely to result in the loss of some potential habitat for this species, as no known population occurs, the Proposal is not considered inconsistent with the draft recovery plan for this species.

Green-thighed frog (*Litoria brevipalmata*) – vulnerable under the TSC Act.

The green-thighed frog is known from isolated localities in rainforest and wet sclerophyll forest along the northern coast of New South Wales and south-eastern Queensland (Cogger 1995). Breeding aggregations of the species occur around grassy semi-permanent ponds in late spring and summer.

The green-thighed frog was recorded in Rawdon Creek Nature Reserve and Maria River State Forest at Site 7. While several records of this species appear in the DECCW Wildlife Atlas for Rawdon Creek Nature Reserve, the colony found at Maria River State Forest appears to be a new location. Heavy rain at the start of the summer survey flooded the creek in the local region and at least ten frogs were observed and heard calling from vegetation surrounding a flooded pool, indicating that this could be an important breeding site. It is likely that this frog species also occurs at other locations along the Proposal.

The proposed alignment travels along the eastern side of the existing highway through Maria River State Forest. This alignment brings the road easement closer to the potential breeding pool located during the summer survey period. As the pool lies within the expected impact boundary, the Proposal could therefore result in the disturbance of a breeding pool for the green-thighed frog and potentially disrupt the breeding cycle for this species. As the size of the local population is unknown, the impacts are difficult to quantify. However if this is an important breeding pool any disturbance could potentially significantly affect the local population of the green-thighed frog.

The widening of the road corridor, increased traffic volumes and vehicle speeds may result in an increased number of road deaths as individuals travel to and from breeding and foraging areas. This would be a particular problem during wet weather. Underpasses may assist in reducing the risk of road death for this species.

The following strategy would be adopted:

- In areas where known habitat for the green-thighed frog would be disturbed, measures to mitigate impacts would be discussed and negotiated with DECCW.. The results of any recent research regarding the breeding requirements of this species or the effectiveness of mitigative strategies implemented on other sections of the Pacific Highway upgrade would be used to inform the design of mitigation measures for the Proposal.
- Potential mitigative measures could include the creation of artificial habitat associated with the existing creek line during construction. The constructed habitat would be designed to mimic the natural situation where breeding occurs within areas of impeded drainage close to sites of intact native vegetation. The pond designs would include the following features as specified for those created for the Kempsey to Eungai section of the Pacific Highway Upgrade (PB 2008):
- Size: 20 metres diameter (core pond), but could be a series of potholes/ponds and larger flooded areas.
- Depth: variable depth to 1 metre.
- Shape: steep sides reducing evaporation and increasing water volumes.
- Length of time for inundation: of the order of 40 days for sunny site, 100 days for shaded site.
- Location: next to moist forest areas if possible.
- Vegetation: dense understorey vegetation or leaf litter.
- An ecologist with specialist knowledge of the green-thighed frog would be engaged to undertake an adaptive monitoring program to determine the effectiveness of mitigation measures and to recommend modifications where necessary.
- The development of specific mitigation and management measures would be undertaken at the detailed design stage to address the habitat of the local Green-thighed Frog population. The mitigation and management measures would be specifically targetted towards minimising any impacts on this population and would be undertaken in consultation with DECCW.

Grey-crowned babbler (*Pomatostomus temporalis temporalis*) – vulnerable under the NSW TSC Act

In NSW the grey-crowned babbler occurs on the western slopes and plains and is less common at the higher altitudes of the tablelands. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (NPWS 2001). The grey-crowned babbler inhabits open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer. This species may also be observed along streams in cleared areas and grassy road verges (Morcombe 2000; NPWS 2001; Readers Digest 1979).

Foraging on insects and spiders, the grey-crowned babbler spends the majority of its time searching through leaf litter and soil for food, but will also venture into vegetation (Morcombe 2000; Readers Digest 1979). These sedentary birds live in groups of 5-12 and defend a territory of approximately 12 hectares (Readers Digest 1979). Although the entire group assists in building a nest and feeding young, there is usually only one breeding pair in each group and they mate for life (Readers Digest 1979). Breeding occurs between July and February (Morcombe 2000). Their large domed nests (up to 50cm wide) are constructed in trees at a height of about 4-7m. They tend to be built into an upward sloping or horizontal, multiple forked branch in the trees upper outer foliage and have a side entrance tunnel (Morcombe 2000). Nest like structures are also used for the babbler families to roost in overnight.

The grey-crowned babbler species was not recorded during the field survey and no records exist for the locality, however some suitable potential habitat occurs in woodland and open forest within the study area. Given the lack of records, the Proposal is considered unlikely to affect the lifecycle of the grey-crowned babbler however it is expected to result in the loss of some potential habitat for this species.

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

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

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

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

The grey-headed flying-fox was recorded at six of the eight base survey sites and four supplementary sites during the Ecotone field surveys. This species was also recorded during supplementary surveys by GHD in November 2007. The nearest known flying-fox camp is at Sea Acres, Port Macquarie and another camp is known from Crescent Head, north of Kempsey and it is considered that this species could seasonally forage anywhere along the road route when local eucalypts are flowering.

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

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

In general, tree-roosting bats are vulnerable to habitat loss and modification, especially the loss of hollow-bearing trees and good quality foraging habitat. These species are also known to roost in the roofs of buildings. Frequent fires or vegetation changes through pollution or weed invasion can impact on the insect prey base on which these species feed. Some predation by feral and domestic cats may occur in some situations. Any activity that reduces prey or roost availability, probably contributes to the cumulative impacts on these species within localities. The wing morphology of all of the subject species indicates that they are fast flyers with reduced manoeuvrability and foraging most frequently occurs above the forest canopy or within the mid to upper canopy of open forests. The loss of forest as foraging habitat is less likely to affect the east-coast freetail-bat and yellow-bellied sheathtail bat as they are often recorded in more open environments, whereas, the greater broad-nosed bat and eastern false pipistrelle often forage along the edge of forest or along roads and open creek lines through forest (Ray Williams, Ecotone Ecological Consultants, pers. obs.). Information on the reproduction cycle of these species is limited, with births reported in December for the eastern false pipistrelle and yellow-bellied sheathtail-bat and January for the greater broad-nosed bat. There is little to no information for the east-coast freetail-bat (Churchill 1998). For all of the subject species, maternity colonies of ten or more individuals have been reported to occur within the upper trunk hollows of large dead or live trees.

The east-coast freetail-bat was positively recorded at Site 1 and the supplementary site near Fernbank Creek through ultrasonic call detection, with a possible recording at the Wharf Road supplementary site. Probable calls of the greater broad-nosed bat were recorded at Site 4 and the Fernbank Creek supplementary site, with a possible call recorded at the Smiths Creek/Wharf Road supplementary site. Possible calls of the eastern false pipistrelle were recorded during Ecotone surveys between Smiths Creek and Wharf Road and also during supplementary surveys by GHD in November 2007 (GHD 2007). The yellow-bellied sheathtail-bat was not recorded during survey work however suitable potential habitat does occur within the study area.

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

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

A long strip of potential foraging habitat is likely be removed or modified as a result of the Proposal. This is unlikely to significantly disadvantage the east-coast freetail-bat, greater broad-nosed bat or yellow-bellied sheathtail-bat to a significant degree, as these species are known to forage in more open environments. The eastern false pipistrelle is known to forage in open forested environments and the Proposal is likely to result in a loss of potential foraging habitat for this species.

The Proposal may also result in an increase in the number of bat deaths by vehicle strike due to increased traffic volumes and vehicle speeds along the new highway.

Koala (*Phascolarctos cinereus*) – vulnerable under the NSW TSC Act.

Distributed from about Townsville, Queensland to the Victorian / South Australian border, from the coast to the western slopes and plains in New South Wales, this species is rare in the north and south of its range and nowhere can it be considered abundant. The koala is a foliovore, feeding on preferred eucalypt species and is found in a variety of habitats where suitable food trees occur (DECCW threatened species profile)

Koalas are generally solitary except during the mating season and have a home range of about 3 hectares, though long movements in search of a mate or new food source are possible (Phillips 1990). The breeding season begins about September, when males commence calling and searching for reproductive females, and ends about April.

No koalas were sighted during the Ecotone surveys, though faecal pellets were recorded at three locations, north and south of Sancrox Road and south of the Maria River bridge. One koala was sighted crossing the existing highway approximately 200 metres south of Sancrox Road during supplementary surveys by GHD in November 2007 (GHD 2007).

Based on the Wildlife Atlas records and communication with local vet and koala expert, Vanessa Standing, this species could occur anywhere along the proposed route, particularly where natural vegetation occurs on either side of the road. The most likely areas, based on available records, appear to be (in order from south to north):

- Either side of Sancrox Road.
- Cairncross State Forest and Rawdon Creek Nature Reserve.
- Cooperabung Hill (Ballengarra State Forest and Cooperabung Nature Reserve).
- Mingaletta Road to Smiths Creek; Kundabung Road to north of Pipers Creek.
- Maria River State Forest.

Based on the information from the Port Macquarie Koala Hospital and Vanessa Standing, the chance of further koala road fatalities is high. The widening of the highway as a result of the Proposal may increase the risk of road death for the koala as animals will have further to travel across the additional lanes to move between vegetated areas. Ameliorative measures such as

floppy top fencing and underpasses along much of the proposed route would assist in minimising future road fatalities.

The project is also expected to result in the loss of a long strip of koala habitat along the proposed route, including the loss of koala food and shelter trees. Where the proposed route deviates from the existing highway and through currently intact native vegetation in Cairncross State Forest, this may cut through individual koalas' home territories, forcing them to cross the new highway in order to move between food and shelter trees. This could potentially result in some koalas being displaced from their current territories and may also impact the dispersal ability of the koala.

The Proposal is unlikely to directly disrupt the breeding cycle of the koala, although the deviation through Cairncross State Forest could isolate females from the breeding male if the road passes through the male's territory. However, the Proposal is likely to lead to increased fragmentation and isolation of koala habitat within the study area and this could potentially affect koala home ranges and the social structure of the population.

A draft recovery plan for the koala has been prepared (NPWS 2003c). The overall objectives of this recovery plan are to reverse the decline of the koala in NSW, to ensure adequate protection, management and restoration of koala habitat and to maintain healthy breeding populations of koalas throughout their current range. Specific objective number two is considered potentially relevant to the Proposal and addresses the issue of rehabilitation and restoration of koala habitat and populations. As the Proposal is expected to result in the loss and further fragmentation of koala habitat, it is considered inconsistent with the objectives of this plan. However, the inclusion of floppy top fencing and fauna underpasses at suitable locations along the Proposal would be an important element of the detailed design to minimise the potential for adverse impacts by facilitating safe fauna movements and potentially reducing the road death toll on koala.

Long-nosed potoroo (*Potorous tridactylus*) – vulnerable under the NSW TSC Act and Commonwealth EPBC Act

The long-nosed potoroo inhabits coastal heath and wet and dry sclerophyll forests in areas with an annual rainfall of greater than 760 mm. A critical habitat requirement is a relatively thick ground cover of grass-trees, rushes, sedges, ferns, heath, low shrubs, tea trees or paperbarks and it seems to be concentrated in areas where the soil is light and/or sandy loams (Johnston 1995). The diet of the long-nosed potoroo consists of roots, tubers, fungi, insects and their larvae, and other soft-bodied soil fauna. Foraging is commenced at dusk and individuals rarely venture far from cover (Johnston 1995). The long-nosed potoroo occupies a stable home range of 1.4 hectares for females to 2.0 hectares for males, with a high degree of overlap, as the species is not territorial (Seebeck 1996). Births may occur throughout the year, but frequently there are two distinct breeding seasons annually, at the end of winter/ early spring and in late summer.

The long-nosed potoroo was not recorded during field survey work within the study area and no records occur within the locality. Therefore it is considered unlikely that this species occurs within the study area, however due to the presence of potentially suitable habitat it cannot be discounted.

The Proposal is likely to result in the removal of a large area of potential habitat for this species. However, given the lack of records it is considered unlikely that the Proposal would affect the lifecycle of the long-nosed potoroo. If a population does occur, individuals could potentially be killed during clearing operations. In addition, increased traffic volumes and vehicle speeds along the new highway could potentially result in an increased risk of road death for the long-nosed potoroo.

Osprey (*Pandion haliaetus*) – vulnerable under the TSC Act and migratory under the EPBC Act

The osprey is distributed in coastal areas and inshore waters of New South Wales, Queensland, Northern Territory, Western Australia, and South Australia. Commonly inhabiting mangroves, coastal rivers, estuaries, inshore seas and coastal islands, the osprey commonly feeds on fish, which are taken by a feet-first plunge. Other dietary components include dead fish, seas snakes, birds, crustaceans, mammals and amphibians (DECCW threatened species profile)

Breeding usually occurs between April and September, in a bulky nest constructed of sticks and sometimes roughly lined with seaweed, in a tall mostly dead but sometimes living trees, with power poles or transmission towers also used (Clancy 1991). Nests are usually located in exposed positions, with easy access and good visibility, generally within 2 kilometres of suitable feeding areas.

The osprey was only recorded once during Ecotone surveys, with two birds observed flying over forest just north of the Hastings River during the habitat assessment stage of the project in November 2005. The osprey was also recorded during supplementary surveys by GHD (GHD 2007). No nest sites were observed or are known to occur within the study area, however two nest sites are known to occur to the east of the study area at Blackmans Point near the Hastings River and at Hatch Road on the edge of Maria River (Tony Bischoff pers. comm.). In addition to the Hastings River area, the osprey is also likely to occur on the Wilson River and Maria River floodplains.

As no nest sites or foraging habitat for the osprey are likely to be affected, the Proposal is considered unlikely to affect the lifecycle of this species, although occasional vehicle strikes could occur.

Pale-headed snake (*Hoplocephalus bitorquatus*) – vulnerable under the NSW TSC Act

The national distribution of the pale-headed snake includes the coast, ranges and western slopes of eastern Australia, from Wyong, Tuggerah and the Hunter Valley in the south, to Cape York in far north Queensland (NPWS 2002). The preferred habitat of the pale-headed snake is regarded as dry hardwood forests and woodlands, especially in the vicinity of watercourses. Moist hardwood forests and rainforests are also known to be utilised by the pale-headed snake (AMBS 1995). The species appears to require vegetation with old-growth features, and is not known to occur in either largely disturbed environments or recently regenerating vegetation. The pale-headed snake is a nocturnal, partly arboreal snake and utilises tree hollows and loose bark for sheltering and foraging. Examination of museum specimens identified frogs and geckoes as the main prey items of this species along with small mammals (AMBS 1995), including bats and mice.

The pale-headed snake was not recorded during field survey work and only two old records exist for the locality. However, suitable potential habitat occurs in forested areas within the study area and it cannot be discounted. The Proposal is expected to result in the loss of potential foraging habitat and shelter sites for the pale-headed snake as well as further fragment habitat for this species. Given the lack of records, it is considered unlikely that the Proposal would greatly affect the lifecycle of this species. However if a local population does occur, individuals of the species could potentially be killed during clearing operations if a shelter site containing a snake lies within the area to be cleared. In addition, increased traffic volumes and vehicle speeds along the new highway could potentially result in an increased risk of road death for the pale-headed snake.

Regent honeyeater (*Xanthomyza phrygia*) and swift parrot (*Lathamus discolor*) – both endangered under the NSW TSC Act and Commonwealth EPBC Act; the swift parrot is also listed as migratory under the Commonwealth EPBC Act.

The regent honeyeater is known to breed on the western slopes of the Great Dividing Range and the swift parrot breeds in Tasmania. Both are seasonal or opportunistic visitors to coastal NSW and forage in areas containing winter-flowering trees (eg. the swamp mahogany and spotted gum). Neither of these species was recorded during the field survey, though both have potential to occur, particularly during peak winter flowering periods.

The Proposal is considered unlikely to significantly affect the lifecycle of either the regent honeyeater or swift parrot. However it is expected to result in the loss of a long strip of potential foraging habitat, including important winter-flowering trees, which would contribute to the cumulative loss of habitat affecting these species. The clearing of potential regent honeyeater and swift parrot habitat is inconsistent with the aims of the recovery plans for these species (Swift Parrot Recovery Team 2001; Regent Honeyeater Recovery Team 1999), though given the paucity of records for both species, the habitat to be cleared is considered unlikely to be critically important to the survival of either species.

Southern myotis (*Myotis macropus*) – vulnerable under the NSW TSC Act

The southern myotis is apparently widespread but uncommon in northern New South Wales (AMBS 1995) and considered comparatively rare over its limited national range (Richards 1983). A variety of foraging habitats are used by this species although it is usually found near large bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to the roost site. The southern myotis forages predominantly just above the water surface of open water bodies but also rakes the surface of the water with the recurved claws of its large feet and sometimes uses its tail membrane as a scoop (Menkhorst 1995).

The species appears to have specific roost requirements and only a small percentage of available caves, bridges, mines, tunnels and culverts are used. Colonies usually number between 10 and 15 individuals, but colonies of up to several hundred individuals have been reported in a single roost (Richards 1983). In New South Wales breeding occurs between October and February with two distinct birthing times occurring in October and early February when a single young is produced. Whether individual females give birth twice in a breeding season is unclear, however, banding studies indicate that this is not the case (Ray Williams, Ecotone Ecological Consultants, pers. obs.).

Loss of roost sites and foraging habitats are considered the major threats to this species. The specific nature of its foraging habits suggest that this species is adversely impacted by habitat degradation through water pollution, and foraging habitat is likely to have been lost through nutrient enrichment, oil spills and pollutant rich run-off entering waterways. Disturbance of colonies, especially during the breeding season or in colder months when the bat is in torpor, may cause populations to desert roost sites and can result in heavy mortality (Ayers *et al*. 1996).

The southern myotis was positively recorded at Maria River Bridge by trapping and ultrasonic call detection during Ecotone survey work within the study area. Probable calls of the species were recorded near Fernbank Creek and possible calls near the large dam at Wharf Road. The southern myotis was also recorded during supplementary surveys by GHD in November 2007 (GHD 2007). During an investigation of potential bat roosts by Ecotone in November 2007, a single southern myotis was recorded roosting in a drainage hole in the roof of the southern culvert at Barrys Creek. In addition to these areas, it is highly likely that the southern myotis would forage along the Hastings and Wilson Rivers. Within the study area, dams, creeklines and rivers represent potential foraging habitat and the southern myotis could potentially roost under bridges and culverts along the length of the proposed alignment.

The foraging activity of the southern myotis is unlikely to be significantly compromised as a result of the Proposal. However if the Proposal were to result in the pollution or degradation of creeklines and other waterbodies within the study area, this could affect the availability of prey species.

Increased traffic volumes and vehicle speeds along the highway could result in an increase in the number of road deaths, though impacts from the potential loss of roost sites are likely to be more relevant to the southern myotis. Although the survey of the bridges and culverts that may be impacted upon by the Proposal during the breeding season failed to find any maternity roosts (Ecotone 2007), such colonies could form by the time that road works commence. As the southern myotis is known to roost under bridges and culverts, the removal of these structures could result in the deaths of roosting individuals, particularly if non-flying young are present or during winter months when bats enter torpor. If a bridge containing a maternity roost was destroyed, this could potentially result in the displacement of an entire colony and loss of young. As this species has two birthing events in a season and more than one roost site would be used by the colony, a new maternity site is likely to be formed and some recruitment of young may still occur. Therefore it is considered unlikely that the Proposal would lead to the extinction of the local population of the southern myotis.

Spotted-tailed quoll (*Dasyurus maculatus*) – vulnerable under the NSW TSC Act; endangered under the Commonwealth EPBC Act

The current distribution of the spotted-tailed quoll is along the coast and ranges of eastern Australia from southern Queensland to the Victorian/South Australian border and Tasmania. The mainland range of this species has been much fragmented and significantly reduced and is now disjunct over much of its former range. The spotted-tailed quoll utilises a wide range of habitat types including rainforest, wet and dry sclerophyll forest, woodland, coastal heathland and inland riparian forest (Edgar & Belcher 1995). The species appears to prefer moist sclerophyll and rainforest forest types, as well as riparian habitat and is most common in large unfragmented patches of forest, favouring dense habitats with a lot of ground litter on the forest floor (DEH 2004).

A solitary, nocturnal and semi-arboreal species, the spotted-tailed quoll preys on a variety of species ranging in size from small wallabies to insects, as well as plants. The spotted-tailed quoll utilises an extensive home range, estimated to be between 500 - 1000 hectares (AMBS 1995).

This species was not recorded within the study area during field survey work, though a few records occur nearby. DECCW's Atlas of NSW Wildlife indicates four main clusters of spotted-tailed quoll records (possibly sub-populations) associated with state forests and nature reserves located to the west side of the existing highway. Nearly all of the records are associated with creeklines within large patches of forest. East of the highway, the species appears to be generally absent, with only a few scattered records.

Road-related deaths are quite common for the spotted-tailed quoll, as the species often scavenges on road kill. The lack of database records along the existing highway suggests that the species is unlikely to use the highway corridor and adjoining habitats, particularly the drier ridgetop forests, on a regular basis, if it does at all. Furthermore, the current distribution of the species, as indicated by the existing records, suggests that core habitat for the species is not likely to be within habitats close to the highway and that the species is unlikely to move between habitats on each side of the highway on a regular basis.

Potential habitat for the spotted-tailed quoll occurs in state forests, nature reserves, national parks and other large forest sections within the study area. No latrine or den sites were recorded within study area, rock shelters and small caves were absent and large logs were generally found to be sparsely scattered throughout the study area. Hence it is unlikely that the study area provides optimal denning habitat.

The dominant vegetation type throughout the study area is dry sclerophyll forest. The vegetation types within the study area most likely to be utilised by the spotted-tailed quoll include Riparian Forest and Moist Gully Forest, which constitute around 11.5 hectares and 40 hectares (51.5 hectares in total) of the study area, respectively. Based on a home range of 500 to 1000 hectares, and the fact that at least four home ranges are likely to be distributed to the west of the study area, this equates to around 1 to 2 per cent of an individual's home range. Hence, it is considered that the Proposal would not remove a substantial portion of habitat that could potentially form part of the home ranges of the individuals or sub-populations recorded to the west of the study area.

Little intact mature forest occurs within the study area and mature, hollow bearing trees tend to be sparsely distributed along the preferred highway route. These are mainly concentrated in less disturbed parts of Cairncross, Ballengarra and Maria River State Forests.

Most areas of native vegetation within the study area contained some degree of fallen timber, however these habitat features were most prevalent in more mature, unlogged bushland.

Vegetation clearance resulting from the Proposal would be of a long, linear nature. The majority of clearing would be adjacent to the existing highway. At present, there is limited capacity for the species to move between habitats on either side of the existing highway. With the installation of new bridges ad fauna crossings, there is opportunity at the detailed design stage to ensure that sufficient passage is provided to allow terrestrial fauna, including the spotted-tailed quoll, to transit safely between habitats on either side of the highway. The species has been recorded using underpasses in gullies and drainage lines (AMBS 1997; AMBS 2001), hence are likely to use bridges as underpasses, providing dry passage is available.

The main potential impacts are likely to be the further fragmentation of habitat, potential loss of den sites and a potential increase in the risk of road fatality.

The Proposal is expected to result in the loss of a long strip of potential foraging habitat for this species. The spotted-tailed quoll utilises large hollow logs, hollow-bearing trees, rock shelters and small caves for breeding and shelter purposes and there is the potential for the Proposal to result in the loss of some of these important habitat features due to clearing along the proposed alignment. As the spotted-tailed quoll utilises a number of den sites within its territory, it is unlikely that the loss of one den site would greatly affect the spotted-tailed quoll. However, if an occupied den site is destroyed, particularly one containing a female with young, this could affect the local population.

The widening of the road corridor is expected to further fragment spotted-tailed quoll habitat, particularly where the proposed route deviates from the current alignment through Cairncross State Forest. This would result in a triangle of habitat becoming isolated from other areas. Given the large home range required, this would reduce the suitability of the patch for the spotted-tailed quoll, potentially displacing the species from that area.

Square-tailed kite (*Lophoictinia isura*) – vulnerable under the TSC Act

The square-tailed kite occurs in coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW the species is a regular resident in the north, north-east and along major river systems and a summer breeding migrant to the south-east. The square-tailed kite inhabits a variety of wooded habitats and exhibits a preference for timbered watercourses. This species preys on passerines, insects and reptiles within the tree canopy and often feeds on young birds stolen from the nest (DECCW threatened species profile)

The square-tailed kite was recorded foraging near Fernbank Creek and also just north of the Wilson River at Telegraph Point during the Ecotone summer surveys in February 2007. It has been recorded as previously nesting near to the existing highway, north of Blackmans Point Road in Cairncross SF/Rawdon Creek NR and near the junction with Wharf Road, Kundabung (Tony Bischoff pers. comm.). However no nests were observed in these locations during field survey work and it appears the tree north of Blackmans Point Road has been removed and severe storm damage has occurred to the trees at Wharf Road.

The Proposal is unlikely to displace the square-tailed kite, though the loss of a long strip of foraging habitat along the proposed route is expected. While this species forages above or within the tree canopy, there is the potential for occasional vehicle strikes to occur.

The square-tailed kite nests on a large limb or fork of a tree and has been previously recorded nesting in the area. While potentially suitable nest trees are likely to be removed as a result of the Proposal, no evidence of a nest was observed within the study area during the field surveys. Unless a nest tree is subsequently discovered and removed as a result of the project it is unlikely that the Proposal would affect the breeding cycle of the square-tailed kite.

Squirrel glider (*Petaurus norfolcensis*) – vulnerable under the NSW TSC Act

The squirrel glider is distributed along the coast and ranges of eastern Australia from about Cairns in north Queensland to the Victorian/ South Australian border, extending to the western slopes and plains. This species usually inhabits dry open sclerophyll forest and woodland but there have been observations in moist regenerating forest and moist gullies. Although requiring nesting/den hollows, this species is not dependent on mature forest as sightings have been made in Eucalyptus plantations and forest remnants (Ray Williams, Ecotone Ecological Consultants, pers. obs.). It is possible that disused common ringtail possum dreys and birds nests are used in the absence of an abundance of suitable hollows. The diet includes acacia gum, eucalyptus sap, nectar, honeydew, manna, invertebrates and pollen (Quin 1995). Survey work indicates a home range of about 13 hectares and a population density of 0.4 - 1 per hectare in a Victorian population (Traill & Coates 1993) and 3.0 - 3.5 hectares with a density of 0.89 - 1.54 per hectare in a mid north coast population (Quin 1995). The breeding season varies between localities and may be tied to the availability of food resources (Williams 1990; Quin 1995).

This species was not recorded within the study area during Ecotone surveys and no records occur within 2 kilometres. However the squirrel glider is expected to occur in larger forest remnants within the study area. This species is reliant upon hollow-bearing trees for roosting and breeding purposes and requires a reasonable level of vegetation connectivity in order to move freely from one area to another. Potential impacts associated with the Proposal include the loss of potential roosting and breeding hollows, the loss of potential foraging habitat and the further fragmentation of habitat associated with the proposed widening of the highway. Ameliorative measures such as aerial rope crossings, trees or poles in the median strip may assist in maintaining habitat connectivity for the squirrel glider. Aerial rope crossings have been installed at the Karuah bypass section of the Pacific Highway and although there is some photographic evidence that these have been used by the squirrel glider, common brushtail possum and the koala, the extent of use has not been determined.

If a population of the squirrel glider does occur within the study area, the Proposal has the potential to displace one or more family groups from their current territories in some areas along the road route. This is particularly the case where large areas of vegetation are likely to be cleared, for example where the proposed route deviates away from the current road alignment and passes through a section of Cairncross State Forest. The removal of large areas of potential habitat could potentially result in an overall decline of squirrel glider numbers within the vicinity of the study area.

A large number of hollow-bearing trees are expected to be lost as a result of the Proposal, some of which were noted to contain potentially suitable roosting and breeding hollows for the squirrel glider. While the squirrel glider will utilise a number of roosts within its home range, the loss of a roost tree contributes to the overall loss of roosting and breeding hollows affecting this species. If a roost tree containing one or more squirrel gliders is removed, this could result in the deaths of those gliders.

The Proposal is likely to further fragment and isolate sections of potential squirrel glider habitat as a result of vegetation clearing within the study area, particularly in Cairncross State Forest where the proposed route deviates away from the existing highway alignment. The widening of the existing road easement would also make it more difficult for the squirrel glider to cross the new highway. Squirrel gliders can cover distances of over 50 metres in one glide depending on the height of the launch tree (DECCW threatened species profile). However glides of less than 50 metres are more common and a road crossing of more than this distance may pose a barrier to movement or deter the squirrel glider from crossing at that point.

It is expected that given a launch tree 20-25 metres tall, a squirrel glider would be able to glide for approximately 40 metres. Currently the highway varies in width between 20 and 40 metres along most of the length of the study area. The squirrel glider is expected to be able to negotiate distances of this order. However, the width of the area of presumed impact for the Proposal is greater than 70 metres along the entire study area. While the squirrel glider may be able to glide across the new highway at a very limited number of locations (where the canopy gap is minimised and suitable launch trees are present) in general the Proposal is likely to result in a barrier to squirrel glider movement and could potentially affect the dispersal ability of this species. Proposed mitigative measures (such as glider poles and aerial rope ladders) will be important for maintaining habitat connectivity for this species.

Stephens' banded snake (*Hoplocephalus stephensii*) – vulnerable under the NSW TSC Act

Stephens' banded snake is an arboreal, nocturnal snake largely restricted to remnant forests in eastern Australia (Fitzgerald et al. 2005) and is usually associated with moist hardwood forest or rainforest (Klippel 1992). The species has also been recorded in rock outcrops, coastal open forest and dry forest types. Key elements of the preferred habitat of this species include a large (greater than 9000ha) area of forest with a large number of hollow bearing trees. In terms of conservation for this species, appropriate management of large areas of forest with abundant hollow trees is necessary, including maintaining the interconnectivity of forest patches. The species mostly forages in arboreal habitats and the tree canopy, where the snakes prey on a range of species including lizards, birds and small mammals including bats (Cogger 1992; DECCW Threatened Species Profile).

Stephens' banded snake was not recorded during field survey work and no nearby records occur, though potential habitat occurs in rainforest and eucalypt forest within the study area. Potential impacts associated with the Proposal include the fragmentation of habitat, loss of hollow-bearing trees and loss of foraging habitat.

If a population of Stephens' banded snakes occurs in the Cairncross State Forest on the eastern side of the highway, then the deviation of the proposed highway route through this section would result in the fragmentation of habitat and further reduce the viability of the patch for Stephens' banded snake. However it is considered unlikely that this snake would occur in that area as Stephens' banded snake requires large areas of forest (greater than 9000 hectares) and the remnant on the eastern side of the highway is only 900 hectares in area and has been heavily logged in many sections.

Given that much of the habitat likely to be affected by the Proposal is marginal for Stephens' banded snake, the Proposal is considered unlikely to greatly affect the life cycle of this species. However, if this species does occur, the widening of the road corridor would increase the fragmentation of Stephens' banded snake habitat within the study area and potentially increase the risk of road death.

Wallum froglet (*Crinia tinnula*) – vulnerable under the NSW TSC Act

The wallum froglet is a small, cryptic species known to inhabit acid paperbark swamps in coastal wallum and heath growing on Quaternary sand (Cogger 1992; Ingram & MacDonald 1993). This species does not tend to colonise permanent waterholes and avoids deep water sites. The main vegetation types include reeds, sedges and ferns, and in particular include the gramminoid clay heaths of *Themeda australis*, *Isachne globosa*, and *Hakea* sp. *A* and wet sedgelands of *Blechnum ambiguum*, *Hypolaena* sp. and *Callistemon pachyphyllus*. Breeding is thought to take place in late

winter, from about July to September as calling takes place from May through to September, although some calling has been heard at other times of the year (Cogger 1992; Robinson 1993).

The wallum froglet was not recorded during field survey work however suitable potential habitat occurs in paperbark and sedge swamps within the study area. The main areas where wallum froglet habitat is likely to be removed or disturbed as a result of the Proposal are in paperbark swamp south of Fernbank Creek and within paperbark and swamp mahogany/forest red gum swamp in Cairncross State Forest and on private land where the proposed route deviates east of the existing highway alignment. Smaller patches of habitat elsewhere within the study area are also likely to be removed.

The Proposal is likely to result in the loss of a large area of potential wallum froglet habitat from within the study area. If a population of this species does occur, this would result in the wallum froglet being displaced from those areas to be cleared and reduce the overall habitat availability for the species.

The wallum froglet is sensitive to changes in water quality and levels of acidity within habitat areas. Any pollution, sedimentation or nutrient runoff into areas of potential wallum froglet habitat could adversely affect the suitability of that habitat. This could potentially disrupt the breeding cycle of the wallum froglet or displace the species from that area, though it is worth noting that wallum froglets have been recorded from roadside habitats. Mitigative measures such as ensuring that best practice sediment and pollution control measures are installed would assist in minimising the risk of these potential impacts.

Wetland birds – Australasian bittern (*Botaurus poicilioptilus*), Australian painted snipe (*Rostratula benghalensis*), black-necked stork (*Ephippiorhynchus asiaticus*), black bittern (*Ixobrychus flavicollis*) and comb-crested jacana (*Irediparra gallinacea*) – the Australasian bittern, black bittern and comb-crested jacana are listed as vulnerable and the Australian painted snipe and black-necked stork as endangered under the NSW TSC Act, with the Australian painted snipe also listed as vulnerable under the Commonwealth EPBC Act.

All five of these species have potential to occur or occasionally visit wet areas within the study area. While habitat preferences differ between the species, suitable potential habitat within the study area includes swamps, creeklines, floodplains, vegetated dams and other wet areas.

The Australasian bittern generally favours permanent, vegetated, shallow freshwater or brackish swamps (Garnett 1992). The black bittern is known to inhabit mangroves, reedy swamps and streamside vegetation including small creeks in forested land (Simpson and Day 2003). The painted snipe generally occurs in shallow, vegetated wetlands, particularly the fringes of swamps, dams and nearby marshy areas (DECCW threatened species profile). The black-necked stork is known from permanent freshwater wetlands, including swamps, floodplains and occasionally mangroves or estuarine areas (DECCW threatened species profile). The comb-crested jacana inhabits swamps, lakes and lagoons with floating vegetation on which it walks and forages (Simpson and Day 2003).

Only one of these species, the black-necked stork, was recorded during field surveys. Two individuals were observed flying over the Stoney Creek Water Sports Park on the Wilson River floodplain, during the spring survey in September 2006. Areas of suitable habitat for wetland birds occur in vegetated swamps, dams and creeklines throughout the study area and the Hastings River and Maria River floodplains.

The Proposal is unlikely to displace any of these threatened wetland bird species. However as the proposed route crosses wetland and floodplain areas, this will result in the removal of some potential foraging habitat for these species. An approximately 2.5 kilometre strip of floodplain south of the Wilson River and a 1.5 kilometre strip south of the Hastings River are likely to be removed as a result of the Proposal. These areas provide potential foraging habitat for the black-necked stork and could also be utilised by the painted snipe. The Australasian bittern, black bittern and comb-crested jacana are less likely to occur in these floodplain areas as a result of the open environment and lack of permanent open water, but could potentially be impacted by changes to water quality in creeks, permanent pools and waterways within the study area. In addition, occasional vehicle strikes could occur if any of these species are foraging near the road.

Yellow-bellied glider (*Petaurus australis*) – vulnerable under the NSW TSC Act

The yellow-bellied glider occurs in tall, mature wet eucalypt forest and is distributed along eastern Australia from Portland, Victoria, to central coastal Queensland. During the day the yellow-bellied glider rests in a den in a hollow branch, usually in a living, smooth-barked eucalypt. It emerges at night to forage, sometimes travelling more than 2 kilometres from the den site. The yellow-bellied glider feeds on plant and insect exudates (sap, nectar, honeydew and manna), with eucalypt blossom providing a valuable food resource when available and insects, spiders and pollen providing most of the protein in the diet (Russell 1995). The usual home range of the species is between 20-85 hectares (DECCW threatened species profile).

This species was not recorded within the study area during Ecotone surveys however the yellow-bellied glider was heard calling in northern Ballengarra State Forest during supplementary surveys by GHD in November 2007. From the literature review and database searches few records of this species occur within 2 kilometres of the study area however potential habitat for the yellow-bellied glider occurs in the larger tracts of forest throughout the study area. This species is reliant upon hollow-bearing trees for roosting and breeding purposes and requires a reasonable level of vegetation connectivity in order to move freely from one area to another. Listed below are the tree species known to be utilised by the yellow-bellied glider for sap-feeding on the north coast (DECCW threatened species profile) that were recorded in the study area are:

- *Corymbia intermedia* (pink bloodwood)
- *Corymbia maculata* (spotted gum)
- *Eucalyptus amplifolia* (cabbage gum)
- *Eucalyptus grandis* (flooded gum)
- *Eucalyptus pilularis* (blackbutt)
- *Eucalyptus propinqua* (small-fruited grey gum)
- *Eucalyptus punctata* (grey gum)
- *Eucalyptus saligna* (Sydney blue gum)
- *Eucalyptus signata* (scribbly gum)
- *Eucalyptus tereticornis* (forest red gum)
- *Lophostemon confertus* (brush box)

Potential impacts associated with the Proposal include the loss of potential roosting and breeding hollows, the loss of potential foraging habitat (including the loss of potential food trees) and the further fragmentation of habitat associated with the proposed widening of the highway. As the yellow-bellied glider tends to occupy intact tracts of forest and the proposed upgrade route generally follows the length of the existing highway (i.e. an already disturbed area), the Proposal is considered unlikely to displace the yellow-bellied glider from its current territories. However a long strip of potential habitat is expected to be removed, including preferred food tree species and a large number of trees containing potential roosting and breeding hollows. If a group of yellow-bellied gliders currently inhabits the area where the proposed route deviates from the existing highway and through currently intact native vegetation in Cairncross State Forest, this may cut through the home territory of that group, forcing them to cross the new highway in order to move between food and roost trees. This could potentially result in some yellow-bellied gliders being displaced from their current territories and may also impact the dispersal ability of the species in this area, depending on the glide distance required to cross the new highway.

The yellow-bellied glider has been recorded gliding distances of up to 140 metres depending on the height of the launch tree however average glide distances are likely to be significantly less than this (DECCW threatened species profile). Currently, the width along the highway varies between 20 to 40 metres for most of its length. The area of presumed impact for the Proposal varies in width from approximately 70 metres to well over the 140 metre maximum glide distance for the yellow-bellied glider. While some regeneration is expected to take place within the road easement post-construction, it would take a number of years for trees to reach a suitable height for gliders to use as a launching post. As a result of widening the highway, the Proposal is expected to further fragment yellow-bellied glider habitat and may affect the dispersal ability of this species in some areas.

A recovery plan for the yellow-bellied glider has been prepared (NPWS 2003d). As the Proposal is expected to result in the loss and further fragmentation of yellow-bellied glider habitat, it is therefore considered to be inconsistent with the objectives of the recovery plan for this species. The proposed widening of the road corridor may prevent or greatly restrict movement of yellow-bellied glider across the highway along much of the length of the study area. Proposed mitigative measures (such as glider poles and aerial rope ladders) would be important for maintaining habitat connectivity.

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

The Proposal is mainly expected to affect threatened fauna habitat within the study area through the clearing of native vegetation. Some water bodies may also be impacted, either by direct removal (in the case of a number of farm dams) or through indirect impacts resulting from pollution and sediment runoff. Given the extent of native vegetation likely to be cleared, the Proposal is also expected to result in the loss of a number of hollow-bearing trees in some sections of the Proposal footprint.

The Proposal is expected to result in the loss of a number of small dams from within the study area. No threatened fauna species were recorded at these locations and while they do represent potential habitat for the green and golden bell frog, given the lack of records and pattern of decline for this species, it is considered unlikely to occur. The southern myotis is likely to forage over dams within the study area and the loss of those dams would reduce the extent of foraging habitat available to this species. However given the large number of dams and other open water bodies within the study area and immediate vicinity this is unlikely to adversely impact the local population of the southern myotis.

A number of creek and river crossings would be required and this has the potential to affect riparian habitat, particularly for the giant barred frog and stuttering frog. Potential impacts include pollution and sediment runoff into waterways and the loss and disturbance of riparian vegetation. These two species are likely to be sensitive to changes in water quality and require suitable riparian vegetation cover (including leaf litter). Other species potentially affected by changes in water quality are the osprey and southern myotis as pollution and sedimentation of waterways may impact prey species. In order to minimise impacts upon these species, ameliorative measures to protect water quality and riparian vegetation cover (including leaf litter) will need to be put in place during bridge construction at the major freshwater creeks within the study area, particularly Barrys Creek, Smiths Creek, Pipers Creek and Yarrabee Road. Ideally, in order to facilitate fauna movement along riparian corridors, sufficient room should be left under each bridge to allow for a continuous vegetated bank along either side of the waterway.

The Proposal is also expected to affect ephemeral waterbodies within the study area. The area of most concern is in Maria River State Forest where a breeding pool for the green-thighed frog was recorded during the summer survey. This ephemeral pool lies within the impact boundary for the proposed new alignment and is likely to be lost as a result of the Proposal. Given the limited information available, it is difficult to determine how the loss of this pool would impact the local population of the green-thighed frog. However, if this is an important breeding pool any disturbance could potentially adversely affect the local population of this species.

Due to the extent of vegetation clearing required, the Proposal is expected to result in the loss of known or potential habitat for a large number of threatened fauna species. The table below shows the extent of each native vegetation community likely to be affected as a result of the Proposal and the threatened fauna species with potential to occur in each community.

Extent of potential threatened fauna habitat loss associated with the Proposal

Vegetation community	Threatened fauna with potential to occur	Predicted impact area (hectares)
1-Moist Floodplain Closed Forest with Rainforest Elements	Barred cuckoo-shrike, insectivorous bats, common planigale, owls, fruit-doves, golden-tipped bat, green-thighed frog, grey-headed flying-fox, koala, pale-headed snake, spotted-tailed quoll, square-tailed kite, Stephens' banded snake, yellow-bellied glider	3.9
2-Riparian Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, owls, giant barred frog, stuttering frog, green-thighed frog, grey-headed flying-fox, koala, pale-headed snake, southern myotis, spotted-tailed quoll, square-tailed kite, black bittern, yellow-bellied glider	7.8

Vegetation community	Threatened fauna with potential to occur	Predicted impact area (hectares)
3-Paperbark Swamp Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, eastern chestnut mouse, owls, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider, wallum froglet	9.5
4-Swamp Mahogany/Forest Red Gum Swamp Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, eastern chestnut mouse, owls, fruit-doves, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider, Stephens' banded snake, wallum froglet, yellow-bellied glider	10.4
5-Swamp Oak Forest	Barred cuckoo-shrike, insectivorous bats, owls, koala, square-tailed kite	0.9
6-Wetland	Giant dragonfly, southern myotis, Australasian bittern, Australian painted snipe, black-necked stork, comb-crested jacana	3.8
7-Moist Floodplain Forest	Insectivorous bats, common planigale, owls, glossy black-cockatoo, green-thighed frog, grey-crowned babbler, grey-headed flying-fox, koala, pale-headed snake, spotted-tailed quoll, square-tailed kite, squirrel glider, yellow-bellied glider	27.8
8-Moist Gully Forest	Barred cuckoo-shrike, insectivorous bats, common planigale, owls, fruit-doves, glossy black-cockatoo, green-thighed frog, grey-headed flying-fox, koala, long-nosed potoroo, pale-headed snake, spotted-tailed quoll, square-tailed kite, squirrel glider, Stephens' banded snake, yellow-bellied glider	25.8
9-Moist Slopes Forest	Brush-tailed phascogale, insectivorous bats, common planigale, owls, glossy black-cockatoo, green-thighed frog, grey-crowned babbler, grey-headed flying-fox, koala, large-eared pied bat, pale-headed snake, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider, yellow-bellied glider	73.9
10-Dry Ridgetop Forest	Brush-tailed phascogale, insectivorous bats, owls, glossy black-cockatoo, grey-crowned babbler, grey-headed flying-fox, koala, large-eared pied bat, pale-headed snake, regent honeyeater, swift parrot, spotted-tailed quoll, square-tailed kite, squirrel glider	39.3
11-Cleared – Scattered Trees	Potential occasional visits by grey-headed flying-fox, swift parrot, regent honeyeater and insectivorous bats. Some large trees may provide potential roost sites for insectivorous bats or a potential nest tree for the osprey. These areas may also provide a corridor link for some species, in particular the koala.	18.6
12-Plantation/Cropland/Market Garden etc.	Potential occasional visits by grey-headed flying-fox, fruit-doves and insectivorous bats for foraging purposes.	1.4

Vegetation community	Threatened fauna with potential to occur	Predicted impact area (hectares)
13-Totally Cleared Open Pasture/Weedy Fallow	Grass owl (in areas of long grass – mainly between Cairncross State Forest and the Wilson River) and black-necked stork (Hastings River and Wilson River floodplains). Some insectivorous bats are likely forage above these areas.	61.3
Total		284.4

The loss of vegetation within the study area associated with the Proposal would include the loss of particular tree species that provide important foraging habitat for a number of threatened fauna species. These include preferred food tree species for the koala, yellow-bellied glider and glossy black-cockatoo as well as important winter-flowering trees (eg. spotted gum, swamp mahogany) that provide an important seasonal food resource for a range of species, including the grey-headed flying-fox, swift parrot and regent honeyeater.

In addition to the loss of foraging habitat for the species in the above table, the clearing of vegetation associated with the Proposal is also expected to result in the loss of sheltering and breeding habitat for a number of these species, particularly due to the loss of hollow-bearing trees. While hollow-bearing trees were generally sparsely distributed throughout the study area, the large clearing footprint of the Proposal would result in the overall loss of a large number of hollow-bearing trees. Threatened species occurring, or considered likely to occur, within the study area that utilise hollow-bearing trees for sheltering and/or breeding purposes include the brush-tailed phascogale, forest owls, glossy black-cockatoo, hollow-roosting bats, pale-headed snake, southern myotis, spotted-tailed quoll, squirrel glider, Stephens' banded snake and yellow bellied glider.

Hollow logs and fallen timber provide potential habitat for a number of threatened fauna species, including the brush-tailed phascogale, common planigale and spotted-tailed quoll. Most areas of native vegetation within the study area contained some degree of fallen timber however these habitat features were most prevalent in more mature, unlogged bushland. Given the large clearing footprint, a large extent of fallen timber is expected to be removed as a result of the Proposal.

As the Proposal may affect bridges within the study area, bat species that roost under bridges and culverts may be affected by the Proposal, including the eastern bent-wing bat, little bent-wing bat and southern myotis. Of these three species, the bent-wing bats are likely to only roost in small numbers under bridges and culverts within the study area, though if these structures are removed while bats are roosting, then individual deaths may occur. The southern myotis is most likely to be affected by bridge removal along the proposed route as this species is known to form maternity roosts under old bridges where suitable hollows occur.

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

The study area is nearing the southern limit for the common planigale, though records of the species do occur further south. It is also at the southern limit for the barred cuckoo-shrike, with only two isolated records of this species occurring south of Port Macquarie (near Stroud). Records of the rose-crowned fruit-dove, superb fruit-dove and wompoo fruit-dove do occur further south of the study area, but they are all more common further north and the study area lies near the southern end of their general distribution. None of these species was recorded during the field survey though potential habitat occurs. The Proposal is expected to result in the loss of potential habitat for these species, though not to the extent that a range reduction would result.

No other subject species are at the limit of their known distribution.

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

Current disturbance regimes within the study area include:

- Grazing.
- Linear infrastructure such as the existing highway corridor and local road network.
- Clearing for agriculture and new development.
- Logging.
- Agricultural activities.
- Quarrying.
- Roadside disturbance.
- Weeds.
- Feral animals.
- Runoff from roads, houses, industrial and agricultural areas.

The Proposal would result in a large extent of native vegetation being cleared and is expected to open up some areas to weed invasion, particularly where the proposed alignment deviates through Cairncross State Forest and north of this area. The Proposal is also expected to increase the area of roadside disturbance such as noise, litter and pollutants from traffic movements and accidental spills.

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

The Proposal is expected to result in the removal of a long strip of remnant vegetation from within the study area, including the removal of vegetation from within mapped areas of key habitat and wildlife corridors. The impact area associated with the Proposal overlaps mapped wildlife corridors and native vegetation is likely to be removed within all of these areas (see Section 2.8). While the existing highway currently presents a barrier to fauna movement, by widening the existing road the Proposal is likely to increase the barrier effect of the highway. Where the proposed route deviates from the existing highway alignment through Cairncross State Forest and north to the Wilson River, this would create an additional barrier to fauna movement and would result in the isolation of an 83 hectare triangle of bushland. These factors are most likely to affect less mobile non-flying threatened fauna species, including the brush-tailed phascogale, common planigale, eastern chestnut mouse, koala, long-nosed potoroo, pale-headed snake, spotted-tailed quoll, squirrel glider, Stephens' banded snake and yellow-bellied glider. Only two of these species, the koala and yellow-bellied glider, were recorded during field survey work within the area, though nearby records of the brush-tailed phascogale, common planigale and spotted-tailed quoll occur.

For non-gliding species, the existing highway already presents a risk of death or injury from vehicle strike, though the proposed road widening is likely to increase this risk as it will extend the time that animals are exposed to traffic. While the Proposal could potentially affect habitat connectivity for all of these non-gliding threatened species, based on the available records the species most likely to be impacted is the koala. At the southern end of the study area a subregional wildlife corridor known to be used by the koala crosses the existing highway between the Oxley Highway and Sancrox Road and road widening would increase the risk of death or injury resulting from vehicle strike. The Proposal would also widen the existing gap where a regional wildlife corridor is mapped

as connecting either side of Cairncross State Forest and Rawdon Creek Nature Reserve across the existing highway. Other areas where the study area crosses mapped wildlife corridors are at Cooperabung Creek Nature Reserve, Ballengarra State Forest, vegetation along Smiths Creek and Pipers Creek, Maria River State Forest, Kumbatine National Park and Kalateene State Forest. Again, while the existing highway already presents a barrier to koala movement, the proposed widening of the highway would increase this gap and decrease the effectiveness of these corridors in facilitating safe koala movement.

For gliding species, the existing highway is already likely to present some form of barrier to movement. However given the glide distances these species are capable of, it is likely that both the yellow-bellied glider and squirrel glider would be able to cross the highway along most areas where large tracts of vegetation occur on either side of the road. Based on the concept design and width of the presumed impact area, the widening of the road corridor is expected to extend this gap beyond the comfortable glide distance for both species along much of the study area. While the yellow-bellied glider is expected to be able to achieve the required glide distance at least in some areas along the route, glides of over 50 metres are likely to be required along the majority of the route and this is expected to pose a difficulty for the squirrel glider.

In one section, the proposed route deviates from the existing highway alignment and cuts through the north-east section of Cairncross State Forest. For species with larger home ranges (particularly the brush-tailed phascogale and spotted-tailed quoll) this deviation may cut through existing territories and expose individuals to greater risk of road death and predation as they could potentially be forced to cross the new highway to move between foraging and shelter/roost habitat. This deviation is also likely to fragment habitat for species with smaller home ranges and may affect territories and social interactions for populations inhabiting that area.

Habitat connectivity for species such as the Australasian bittern, Australian painted snipe, black bittern, giant barred frog and stuttering frog is unlikely to be affected as these species would be able to cross under the new highway along riparian corridors or floodplain areas at bridge crossings. Frog species (in particular the green-thighed frog) that may periodically cross the highway during the breeding season or wet weather may be more susceptible to the risk of road death as a result of the road widening. Ameliorative measures such as underpasses and connecting turfed dish drains may assist in directing frogs under the road and avoid the risk of being run over.

In summary, it is considered that the Proposal would create an increased barrier between areas of habitat for a number of threatened fauna species by isolating areas of habitat and increasing the distance between areas of remnant vegetation along mapped wildlife corridors within the study area. A number of measures may assist in ameliorating these impacts and reduce the risk of road deaths, including fauna underpasses and aerial rope crossings in association with floppy-top fencing. Roadside signs advising motorists of the presence of koalas may also assist in raising driver awareness of the need to drive carefully and watch out for animals crossing the road.

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

No critical habitat is currently listed in the NSW TSC Act or Commonwealth EPBC Act for the subject species within the study area.

Conclusion to Part 3A Assessment for threatened fauna

It is considered unlikely that the Proposal would result in impacts of the magnitude that would cause a local population of threatened fauna to become extinct, based on the following:

- Appropriate mitigation measures would minimise impacts on local populations of the koala, green-thighed frog and giant-barred frog, which have been identified as species' particularly vulnerable to potential impacts associated with the Proposal. For the koala, these measures include provision of fauna underpasses and fauna exclusion fencing. For green-thighed frog and giant barred frog, these measures include targeted surveys, a monitoring program, and consideration to construction of artificial habitat breeding ponds to provide alternative habitat. The location, size and design of these ponds would be considered at the detailed design and construction stages in consultation with DECCW.
- Dedicated fauna underpasses, combined drainage/fauna movement culverts, aerial fauna crossings and glider poles in conjunction with wildlife exclusion fencing have been incorporated into the Proposal design to reduce the potential for adverse impacts on native wildlife as a result of habitat fragmentation barrier effects and road mortality.
- A range of pre-clearing survey protocols would be implemented during the construction phase of the Proposal, including inspections of hollow-bearing trees and staged clearing, to minimise the chances of death or injury to native fauna during the clearing and construction phases.
- Although the Proposal would contribute to general fragmentation of natural vegetation, including at least one EEC, the remaining areas of natural vegetation on either side of the deviation through Cairncross State Forest are considered large enough to continue as functioning ecosystems.