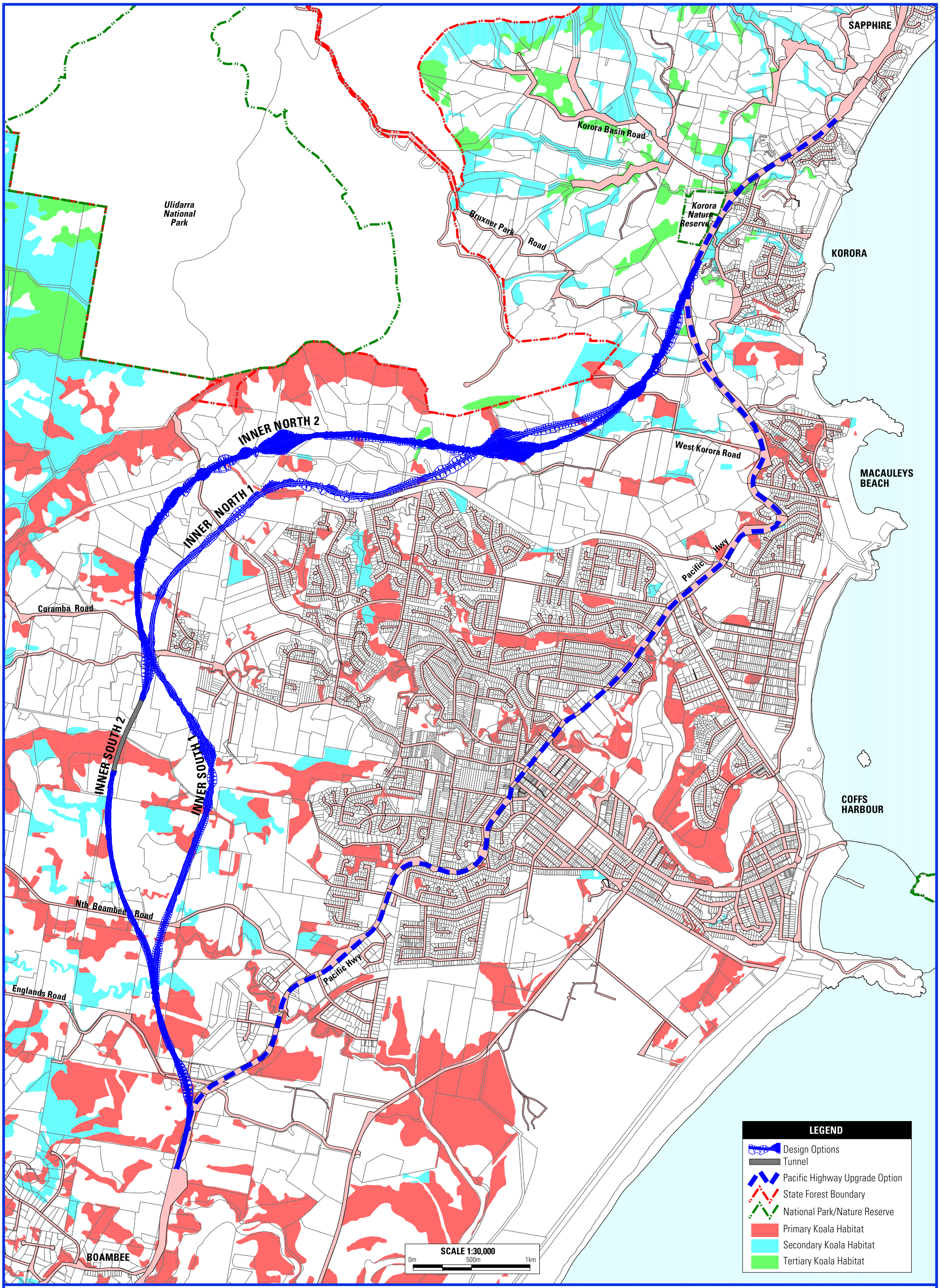

COFFS HARBOUR HIGHWAY PLANNING
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FIGURE 3
KOALA HABITAT MAP

(Source: Coffs Harbour City Council)

Considering Primary Koala Habitat is the most significant category, and that there is little distinction between the Inner Bypass Options on the basis of impacts on Secondary and Tertiary Koala Habitat, the impact of the Inner Bypass Options is predominantly related to Primary Koala Habitat. As such, it is considered that the Options IS2 / IN2 and IS2 / IN1 have a similar, but lower impact, than Options IS1 / IN1 and IS1 / IN2.

All Inner Bypass Options and the Existing Highway Option affect Koala movement corridors. These are discussed below.

Fragmentation of Habitats

The Inner Bypass Options and the Existing Highway Option have the potential to impact on areas of contiguous habitat, Koala movement corridors and wildlife linkages. For the purposes of this study, the fragmentation of a contiguous habitat is, for example, the division of a single (contiguous) area of bushland into two or more areas by placing a roadway through it. Decreased continuity has the potential to disrupt movement, increase edge to interior ratio and decrease the amount of habitat available. The fragmentation of a contiguous habitat is discussed below.

A roadway can also have a similar effect by disrupting a wildlife linkage that joins two separate areas of bushland located in a cleared landscape. Studies have identified wildlife linkages in the study area. Lunney et al. (1998) has identified Koala movement corridors, and regional and sub-regional movement corridors have been identified from the DEC Key Habitats and Corridors Project (Scotts, 2003) (Figure 4). Potential impacts on Koala movement corridors and wildlife linkages are considered separately to the fragmentation of a contiguous habitat, and are discussed below.

Contiguous Habitats

The impact assessment of habitat continuity is based on a visual assessment of the impact of each Option on the size and continuity of habitat in the study area (see Section 2.1, Figure 2).

The continuity of habitats is important for a number threatened species, due to factors such as:-

- Specific habitat preferences for large, continuous areas of habitat for species such as the Red Goshawk and Square-tailed Kite;
- The larger potential carrying capacity for populations of threatened species, and accordingly the decreased likelihood of localised extinction due to inability to recolonise a disturbed area; and
- The lower number and / or level of threats such as road kill, predation or competition from animals associated with edge environments.

Clearing for agriculture and urban development has fragmented much of the bushland in the study area. The Inner Bypass Options and the Existing Highway Option pass through or close to several of these bushland remnants. While these vary in size and shape, they are significantly smaller than areas of contiguous habitats to the west (See Section 2.1, Figure 2). As such, on a broader, more regional scale, the impact on the continuity of habitats posed by the Inner Bypass Options or the Existing Highway Option is considered negligible due to the absence of substantial tracts of native vegetation.

On a local scale, the Inner Bypass Options and the Existing Highway Option have the potential to fragment areas of native vegetation. Due to the presence of the existing highway, the Existing Highway Option is expected to have a negligible impact on the continuity of habitats. The Inner Bypass Options however, would fragment remnants of native vegetation, thereby decreasing the continuity of habitats. A number of remnants that may be fragmented occur on the north and south along the shared alignment of the Inner Bypass Options (See Section 2.1, Figure 2).

All Inner Bypass Options pass through a similar number of bushland remnants, which are typically linear and have high edge to interior ratios, with minimum width of approximately 20 to 100m. The importance of these remnants is considered to be lower than larger areas with a lower edge to interior ratio, as they

are more vulnerable to degradation, provide less habitat and may be subject to higher levels of threat, such as from predatory or territorial edge species.

Option IS2, however, passes via a tunnel under a larger, wider remnant of bushland (See Section 2.1, Figure 2), which is approximately 240 m wide at the point where Option IS2 crosses to a maximum of approximately 470 m wide 1km to the west. NPWS (1997) noted that strong edge effects have been observed on avifauna within 15 metres from the edge of a forest, with true forest dependent species not likely to become established until 250 metres from an edge. This indicates that, aside from simply being larger, this remnant of vegetation may provide habitat for more forest dependent fauna.

The lower level of impact of Option IS2on bushland that may provide habitat for forest dependent fauna is relatively unique to this Option, and as such it is considered likely to have a lesser impact on the continuity of habitats at a local scale. It should be noted that changes to the habitat such as understorey clearing, (not obvious on vegetation maps or aerial photography) , may have reduced the habitat value of this area of bushland to such an extent that it provides poor quality habitat for forest dependent fauna.

Koala Movement Corridors

Options IS2 / IN1 and IS2 / IN2 will pass through the same number of Local and Regional movement corridors for Koalas (Figure 4). Options IS1 / IN1 and IS1 / IN2 will have a slightly higher level of impact, passing through one additional of Local movement corridor for Koalas (Figure 4). Considering the proximity of the Inner Bypass Options and the similarity between movement corridors crossed, the impacts of each Inner Bypass Option are considered largely similar.

The Existing Highway Option passes through a number of movement corridors for Koalas. As the Existing Highway Option currently crosses these corridors, the principal impact of a Highway upgrade could be to exacerbate the existing hazard by creating a wider road crossing. However, it is likely that a future Highway upgrade would require the provision of fauna underpasses at identified Koala movement corridors, which would serve to mitigate this impact. As such, the impact of the Existing Highway Option on Koala movement corridors is considered negligible.

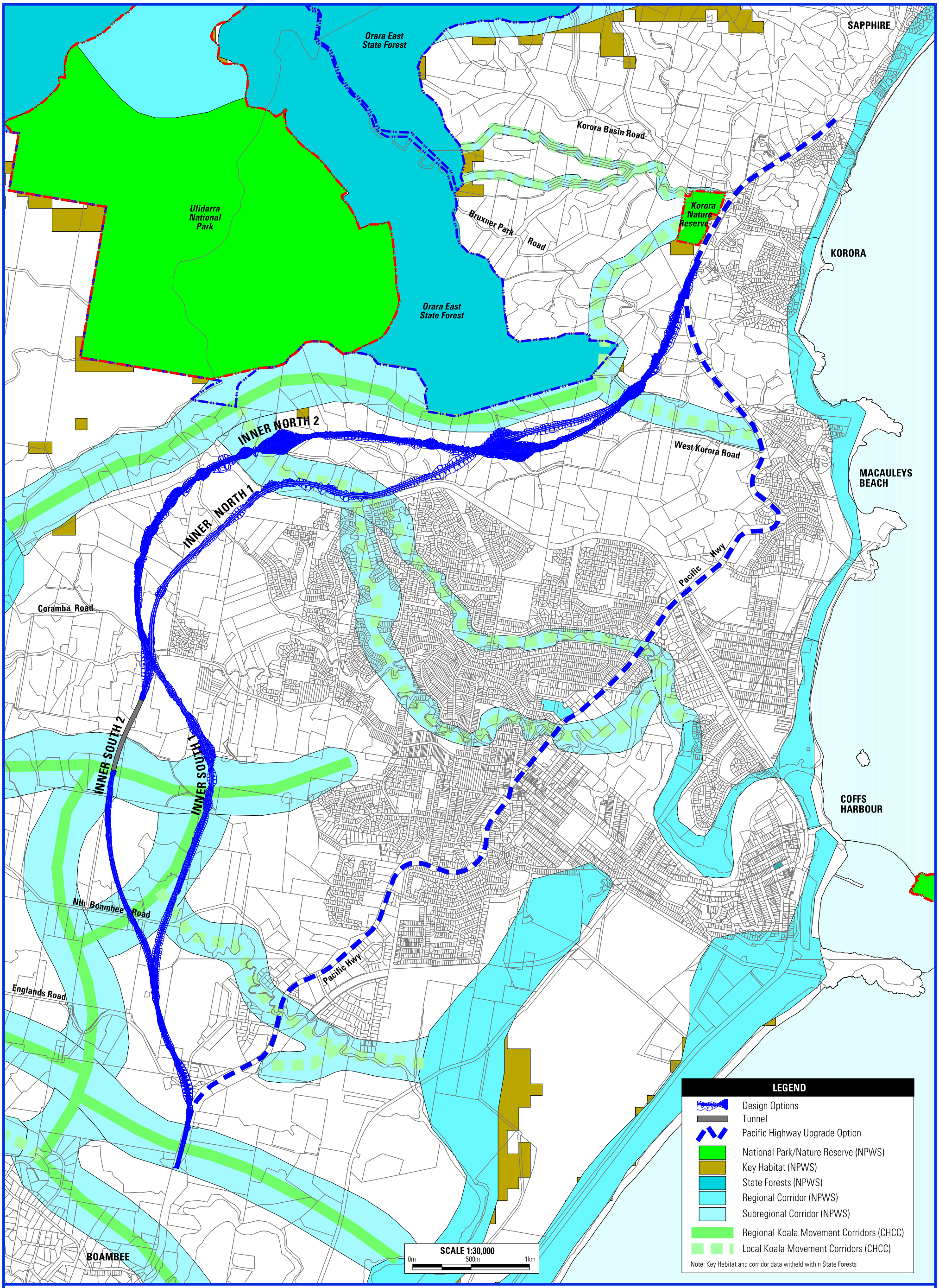
Wildlife Linkages

The DEC Key Habitats and Corridors Project identified Regional and Sub-Regional Corridors as those that provide linkage corridors for species assemblages, that are intended to maintain ecological processes such as migration, dispersal, predation and pollination. These processes are required for the long term viability and interaction of an ecosystem.

An examination of aerial photography indicated that the linkages identified by Lunney et al. (1998) and the DEC Key Habitats and Corridors Project recognised all linkages crossed by the Inner Bypass Options and Existing Highway Option. There are numerous small linear remnants of vegetation crossed by the Inner Bypass Options that are not considered linkages, as they do not serve to connect areas of habitat.

As with Koala movement corridors, the Existing Highway Option passes a number of wildlife linkages. As the existing highway currently crosses these linkages, the principal impact of a Existing Highway Option would be to exacerbate the existing hazard, which may be mitigated by the provision of fauna underpasses at identified wildlife linkages. As such, the impact of the Existing Highway Option on wildlife linkages is considered negligible.

Options IS 1 / IN1 and IS 1 / IN2 pass through a number of linkages, which considering the proximity of the Options and the commonality between linkages crossed, the impacts of each Option are considered similar. Options IS 2 / IN1 and IS 2 / IN2 pass through a similar number of linkages to Options IS 1 / IN1 and IS 1 / IN2, however, maintains a large corridor to the south of Coramba Road (Figure 4), which Options IS 1 / IN1 and IS 1 / IN2 would cross. As such, Options IS 2 / IN1 and IS 2 / IN2 are considered to have a lower impact on wildlife linkages than Options IS 1 / IN1 and IS 1 / IN2.



COFFS HARBOUR HIGHWAY PLANNING
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FIGURE 4
KEY HABITATS AND CORRIDORS

While there is a large degree of similarity between the Inner Bypass Options, it is clear that the level of impact is likely to be greater than that posed by the Existing Highway Option .

The Tree Hollow Resource

Hollow bearing trees are a critical habitat feature for a number of threatened species (Gibbons and Lindenmayer 2002), providing breeding and / or sheltering habitat. Gibbons and Lindenmayer (2002) found that hollow bearing trees were more common in older stands, gullies, vegetation not logged and on flat terrain. Habitats with high productivity were also noted to support a higher number of hollow bearing trees.

In the North Coast Bioregion, a study of forests broadly similar to those in the study area, Andrew et al. (1994) found the abundance of large tree hollows (possibly greater than 30cm diameter at entrance) did not increase with the increase in productivity. Forests characterised by *Eucalyptus saligna*, *E. microcorys*, *E. acmenoides*, *E. grandis,* being species associated with more productive areas, had less hollow bearing trees than forests characterised by *Eucalyptus punctata*, *E. acmenoides*, and *Corymbia maculata* (Table 2.9). This lack of definition may indicate that other factors, namely those mentioned above, are a better predictor of tree hollows than the community type.

From Andrew et al. (1994), rainforests have a lower abundance of tree hollows, despite being located in environments that are more productive. This is thought to reflect the importance of eucalypts (*Angophora sp*., *Eucalyptus sp*., *Corymbia sp*. and *Syncarpia sp*.) in providing hollows, both of which are less common or absent from rainforests.

Table 2.9: Hollow Bearing Tree Density

Dominant Tree Species (Andrew et al. 1994)	Comparable Vegetation in Study Area	Large Tree Hollows per Hectare	
		(*not logged*)	(*logged areas*)
Eucalyptus saligna, *E. microcorys*, *E. acmenoides*, *E. grandis*	Moist Blackbutt Tallowwood Flooded Gum	6	5.6
Eucalyptus punctata, *E. acmenoides*, *Corymbia maculata*	Blackbutt / Bloodwood Apple Dry Blackbutt	10	5
Subtropical Rainforest	Booyong	2-6	0

Analysis of aerial photography, contour maps and vegetation maps for habitats likely to be more productive of tree hollows did not reveal any obvious differences between Inner Bypass Options. Furthermore, the similarity of the level of clearing for each Option does not indicate that any particular Option may have a greater impact on this resource. It should be noted that this is a generalised analysis, with the abundance of hollow bearing trees being determined by a mosaic of environmental and land use factors that could vary across the study area.

Winter flowering trees

Flowering is more pronounced in the warmer months of the year. Many threatened species require winter flowering species to supply food year-round, or to coincide with migratory movements. As such, the presence or absence of winter flowering species is considered a limiting factor for a number of threatened species.

From information provided in Law et al. (2000), canopy species in the study area that flower in winter are the Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*Eucalyptus robusta*) and the Forest Red Gum (*Eucalyptus tereticornis*). It should be noted that winter flowering is not restricted to these species. However, as it more common in these species it is likely to provide a more reliable resource and hence be of greater importance.

From the description of vegetation in the study area (Fisher et al. 1996), it is clear that a number of winter flowering species occur relatively commonly in a number of vegetation communities likely to be impacted

by the proposal. The winter flowering species and associated vegetation communities (from Fisher et al. 1996) are detailed in Table 2.10.

Table 2.10: Winter Flowering Canopy Species and Vegetation Communities

Vegetation Community	Winter Flowering Canopy Species
Blackbutt / Bloodwood Apple	Blackbutt (*Eucalyptus pilularis*)
Dry Blackbutt	Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*E. robusta*)
Moist Blackbutt	Blackbutt (*Eucalyptus pilularis*)
Paperbark	Forest Red Gum (*Eucalyptus tereticornis*), Swamp Mahogany (*E. robusta*)
Swamp Mahogany	Forest Red Gum (*Eucalyptus tereticornis*), Swamp Mahogany (*E. robusta*)

The Existing Highway Option passes a number of native vegetation types, which may contain the Blackbutt (*Eucalyptus pilularis*), Forest Red Gum (*E. tereticornis*) and Swamp Mahogany (*E. robusta*). The loss of winter flowering trees is likely to be minimal under this option due to the presence of the existing road corridor, and is much less than for the Inner Bypass Options, as can be seen in Section 2.1, Figure 2.

The Inner Bypass Options pass through a range of vegetation types as listed in Table 2.9, and are likely to impact on a range of winter flowering resources. The removal of winter flowering tree is likely to be greatest for Option IS1 / IN2, followed by Option IS2 / IN2, Option IS1 / IN1 then Option IS2 / IN1 (Table 2.7). However, the removal of vegetation characterised by winter flowering species did not differ more than 0.5ha, which is considered a negligible difference. As such, the impacts of each Option on winter flowering trees is considered to be similar and does not serve to distinguish the Inner Bypass Options on the basis of impact.

2.3 Aquatic Species Assessment

Aquatic habitats provide suitable habitat for a number of threatened species listed under the *Threatened Species Conservation Act 1995* (Table 2.11), namely threatened wetland birds and amphibians. Aquatic habitats also provide habitat for a number of threatened species listed under the *Fisheries Management Act 1994*. The assessment of the Inner Bypass Options and Existing Highway Option examines species listed under each Act separately in the following sections.

2.3.1 Species listed under the Threatened Species Conservation Act 1995

This section examines the impact of the Inner Bypass Options and Existing Highway Option on species listed under the *Threatened Species Conservation Act 1995* associated with aquatic habitats (see Table 2.5). The number and characteristics of water courses and dams crossed was estimated for each Option from Aerial photography. The number and characteristics of water courses and dams crossed is presented in Table 2.11.

Table 2.11: Number of Water Habitats Crossed by each Option				
Habitat Type	**Option IS1 / IN2**	**Option IS2 / IN1**	**Option IS2 / IN2**	**Option IS1 / IN1**
Water Courses:				
fringing vegetation	5	5	5	5
predominantly cleared lands	7	5	4	8
Large dams:				
in vegetation	1	1	1	1
fringing vegetation	5	2	5	2
not vegetated	7	3	5	5

The value of watercourses in clear lands and dams with no vegetation cannot be discounted, but at this level of study, there is little to indicate these areas have any particular conservation significance. As such, considering the features that provide the most suitable habitat for threatened species (water courses with fringing vegetation and large dams set into vegetation or on the fringes of vegetation), it would appear that Option IS1 / IN2 and Option IS2 / IN2 have the highest potential level of impact on the habitats of threatened species associated with aquatic habitats.

2.3.2 Species listed under the Fisheries Management Act 1994

No high-conservation value fish species were listed within the Australian Museum Database for the study area. It was recognised that very little surveying had been undertaken in the waterways in the study area. Surveying had been concentrated to the west and the north-west of the study area, focussing on the Orara River catchment (Bucca Bucca Ck. subcatchment) and the Corindi River catchment.

Information from outside the study area indicates that two threatened fish species, listed under the *Fisheries Management Act 1994*, are present in waterways to the west and north west of the study area. These are the Eastern Freshwater Cod and the Oxleyan Pygmy Perch.

The Eastern Freshwater Cod is listed as *endangered* under the NSW Fisheries Management Act 1994 and is thought to naturally occur only in the Mann & Nymboida river systems (NSW Fisheries 1999). However, Anderson and Howland (1998) have recorded Eastern Cod in the Orara River system, located to the west of the study area. The habitat requirements of Eastern Cod is poorly known, but probably resemble related species (NSW Fisheries 1999). Cod are typically found in clear flowing rivers with rocky substrate and large amounts of in-stream cover. Recent research observations have indicated that Eastern Cod are typically associated with deeper parts of the river near cover, especially around rocky islands and large boulders in fast-flowing water.

It is highly unlikely that the Cod occurs naturally in any other catchments traversed by the Inner Bypass Options or the Existing Highway Option , however, the habitats of this species may occur along the Options. It is possible that this species has, or will be, released from stock into suitable habitats in the study area. However, no breeding has been observed in releases (NSW Fisheries 1999) and is generally being restricted to naturally occurring populations in more pristine environments. Indeed, there are a number of anecdotal observations of the onset of agricultural land uses and other disturbances (that lower water quality) coinciding with rapid population declines (NSW Fisheries 1999). This would indicate that breeding in disturbed habitats such as the Options is not likely.

The Oxleyan Pygmy Perch is listed as endangered under the *NSW Fisheries Management Act 1994* and is found only in small streams and lakes in coastal heath, and is threatened by habitat destruction and introduced fish. This species has been recorded in the Australian Museum Database in Red Rock

National Park, which flows into the Corindi River. Considering the distribution map presented in NSW Fisheries (2001), it is possible that the Perch exists in catchments traversed by the Options.

As neither the Inner Bypass Options or the Existing Highway Option cross small streams and lakes in coastal heath, no direct impacts are likely to occur. However, as the Inner Bypass Options and Existing Highway Option drain to areas that may contain suitable habitat to the east, there may be indirect impacts, such as decreased water quality. Considering that the Inner Bypass Options and Existing Highway Option catchments drain into largely cleared urban or agricultural lands, the adoption of appropriate water quality controls would minimise the potential for indirect impacts to present a greater level of disturbance than currently exists.

Distributional information provided by Morgan (1997) indicated that possibly two species of Spiny Crayfish of high-conservation value may occur in catchments traversed by the Inner Bypass Options. The most likely species of Spiny Crayfish is *Euastacus dangadi*. The least likely species, *E. neohirsutus*, is typically found in small, very-cool creeks fringed by rainforest on high (480-710 m ASL), more exposed ridges. However, some specimens have been collected down to 70 m ASL. These species are most likely to be found in waterways in the State Forests and National Parks to the west and north-west of the study area. Due to the need for cool, clean, well oxygenated water, it is considered that this species is unlikely to occur along the Existing Highway Option, however, there is a small chance it may occur along the Inner Bypass Options.

2.4 Comparison to the draft Coffs Harbour City Vegetation Strategy

The proposed strategy aims to provide a clear and consistent framework for the conservation and management of native vegetation within the Coffs Harbour City Council Local Government Area. As part of this strategy, vegetation in the Local Government Area has been divided into four classes of ecological significance. Ecological significance was derived from data including the level of conservation, growth stage, biodiversity levels, Koala habitats, Key Habitats and Corridors, Remnant size and condition.

The four classes of ecological significance, include Very High, High, Moderate and Low areas of ecological value. The Very High habitats are those with special values, such as poorly conserved vegetation, primary Koala habitat and significant ecosystems, such as wetlands and wetlands (Ecograph 2002). High Value habitats also contain special values, however, at lesser levels than Very High habitats, but considers attributes related to function and viability such as large tracts of forest, corridors and key habitats. The moderate category may contain inadequately conserved habitats, however, these are expected to not be as functionally significant as those in High. The Low habitats are those that do not fall in to the previous categories, and include disturbed areas such as regrowth and native plantations (Ecograph 2002).

The level of habitat removal for each level of Ecological Value, as shown in Table 2.12, is considered to be largely similar for each Option. The Existing Highway Option passes a number of native vegetation types of varying Ecological Value. Due to the presence of the existing highway, the loss of habitats for these species is likely to be minimal, and the provision of impact minimisation measures, such as regeneration and revegetation, is likely to adequately mitigate this impact.

Table 2.12: Removal of Ecological Significance for each Option

Ecological Significance Category	IS2 / IN1 (ha)	IS2 / IN2 (ha)	IS1 / IN1 (ha)	IS1 / IN2 (ha)
Very High	8.6	9.1	9.2	9.7
High	1.1	2.2	0.9	2.0
Moderate	0.3	0.08	0.026	0.002

3. Discussion and Conclusion

3.1 Discussion

The examination of ecological impacts associated with both options consistently indicate that the Inner Bypass Options are likely to have a higher impact on threatened species and vegetation of conservation than the Existing Highway Option. This is largely attributed to the existing highway passing through developed lands, an offset being that the Existing Highway Option will require less clearing. Habitats in the immediate areas adjacent to the existing highway are likely to have been degraded by edge effects and other and other associated disturbances.

3.2 Conclusion

The likely impacts associated with each Inner Bypass Option were generally similar in regard to:-

- Vegetation Clearance;
- Aquatic Habitats;
- The Tree Hollow Resource; and
- Winter flowering trees.

The likely impacts associated with Options IS2 / IN1 and IS2 / IN2 were lesser than Options IS1 / IN1 and IS1 / IN2 in regard to: -

- Koala Habitat; and
- Wildlife Linkages.

Option IS2 / IN1 and IS2 / IN2 had a relatively lower level of impact on Koala Habitat and the fragmentation of contiguous habitats, which was the result of this Option passing in tunnel through a single, relatively large area of bushland. However, this area of bushland was only considered the minimal size to provide habitat for forest dependent fauna (based on avifauna).

Despite the differences in potential impacts, the Inner Bypass Options and Existing Highway Option would require the provision of fauna underpasses and / or overpasses due to the presence of wildlife linkages that include a number of Koala movement corridors. However, in the case of the Existing Highway Option, these would provide some improvement over the existing situation as they could potentially improve linkages already impacted by the existing highway corridor.

3.3 Comparison to the draft Coffs Harbour City Vegetation Strategy

The level of habitat removal for each level of Ecological Value is considered to be largely similar for each Option, which is considered to be broadly consistent with the findings of this study. However, as the measure of Ecological Value is a combination of a number of factors, it is somewhat limited in its ability to distinguish between Options when differences are related to one or a small number of factors, in this case Koala Habitat and Wildlife Linkages.

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