Flora species

A total of 1159 flora species were recorded across the study area from 210 plant families. The total list of plants is provided in Appendix F and comprises 1002 native indigenous species (86.5 per cent of the total species) and 157 exotic species. Species richness was similar between project sections and greatest in sections 3-8. This variation is likely to be a result of the distance of each project section rather than survey effort or vegetation condition (eg sections 3-8 comprise 98.3 kilometres of the project).

3.5. Fauna habitats

3.5.1. Fauna habitat types

The coastal location of the project, combined with wide elevational and topographic variation, fertile soils interspersed with infertile soils, high rainfall and mild climate, have resulted in a mosaic of fauna habitats.

The eucalypt-dominated sclerophyll forests are the most widespread fauna habitat across a range of topographies and soil types from the alluvial plains to sandstone coastal ridges and coastal sands. Dry sclerophyll forests are proportionally the most abundant habitats and are represented across the whole project, followed by swamp forest habitats which dominated the Clarence River and Coldstream River floodplain habitats from Glenugie to Iluka Road (section 3-5). Wet or moist habitats are more restricted to sheltered slopes and gullies and narrow riparian areas, and are represented along most sections (in particular across the Dirty Creek and Summervale Range (section 1) and sections 6-7). Portions of the coastal plain in the north of the project around Broadwater and Wardell (sections 8-9) traverse wallum habitats supporting fire-prone sclerophyllous vegetation on low nutrient sands. North of the Richmond River on the Richmond alluvial plains vegetation is typically swamp forests and fragmented examples of lowland rainforest and wet sclerophyll habitats.

Fauna habitat types and threatened fauna (also documented in Section 3.4.10) recorded in the study area are described below. Habitat distribution and confirmed records of threatened fauna identified from the targeted surveys are shown in Figure 3-34 to Figure 3-59.

Dry forest habitats

Dry forest habitats are proportionally the most abundant habitat along the project boundary and encompass a large range of vegetation types represented across all project sections. This habitat also contains the highest proportion of hollow-bearing trees and tree hollows. It provides important habitat for a range of fauna groups, particularly hollow-dependent species such as forest owls (eg Masked Owl and Powerful Owl), arboreal mammals (eg Yellow-bellied Glider, Squirrel Glider and Brush-tailed Phascogale), hollow-dependent bats (eg Hoary Wattled Bat, Eastern Freetail Bat and Eastern Long-eared Bat and various other fauna such as the Glossy Black-cockatoo and Brown Treecreeper. Dry open forest habitats also provide a range of food resources for fauna including:

- Mixed eucalypt species providing a year-round supply of nectar and pollen, and food resources for ecological specialists such as Koalas and Glossy Black-cockatoo
- Structural diversity, offering a range of foraging substrates (such as peeling bark, fallen logs, leaf litter, shrubby understorey, grassy groundcover) and 'spaces' for fauna.

Wet and riparian forests and floodplain eucalypt habitat

Wet sclerophyll and semi-mesic forest occur throughout the project boundary, on mid- to lower-slopes of low undulating rises. The community is dominated by flowering trees (Myrtaceae), providing habitat resources for a suite of fauna, including tree hollows, fallen wood, leaf litter, shrubby understorey, grassy groundcover, and a year-round supply of nectar and pollen.

The most commonly encountered floodplain forest associations in the project boundary are Eastern Red Gum Floodplain Forest, and Forest Red Gum Floodplain Forest. The dominant species are Forest Red Gum. They are moderately tall to tall woodland and open forests, supporting hollow-bearing trees, flowering trees and shrubs, and abundant fallen wood. This habitat type is frequented by woodland and forest birds, arboreal and terrestrial mammals, bats, numerous reptiles and often frogs.

Riparian zones are ecotones between aquatic and terrestrial habitats. They comprise elements of both adjacent aquatic and terrestrial habitats, as well as riparian specialists, and as such are areas of high diversity and productivity. They also generally support relatively higher structural and floristic diversity than surrounding open forests, with higher density of larger mature trees. Riparian zones are also important in the landscape because they are often the only remnant vegetation in cleared areas, offering fauna safe corridor habitat for movement, as well as refuge habitat during drought or other adverse weather and climatic conditions, such as fires. Riparian habitats can also act as buffers against the impact of agricultural runoff such as nutrients and sediment and hence assist in maintaining water quality.

These riparian zones include areas of moist forest, rainforest and mangrove elements along larger tributaries, in agricultural areas that have been subject to clearing of the floodplain. Remnant and regrowth riparian areas also occur in logged and unlogged open forest habitats. This habitat type is representative of the natural vegetation of the locality, although weed invasion as a consequence of detrimental edge effects and frequent fires is common.

Riparian habitats include tall moist forest to heights of 35 metres, dominated by Blackbutt, Flooded Gum, Brushbox and Tallowwood with rainforest and/or swamp elements in the understorey. Threatened species known to roost, nest or forage in riparian habitats in the study area include Black-necked Stork, Black Bittern, Square-tailed Kite, Osprey, Golden-tipped Bat, Southern Myotis and tree roosting microbats. The Giant barred Frog and Stuttering Frog could also be expected to occur within riparian habitat.

Swamp forest habitat

Swamp Sclerophyll Forest occurs on seasonally waterlogged floodplain or swampy creek lines throughout all sections, mostly on the Clarence and Richmond river floodplains. Swamp Sclerophyll Forest provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al*. 2000). The blossoms of

Swamp Mahogany (*Eucalyptus robusta*) and Broad-leaved Paperbark are also an important food source for the Grey-headed Flying Fox and Common Blossom Bat (Law 1994), as well as the Yellow-bellied Glider, Squirrel Glider, Regent Honeyeater and Swift Parrot and Little Lorikeet. Other species which may use Swamp Sclerophyll Forest includes Osprey, Australasian Bittern, Southern Myotis, Olongburra Frog and Wallum Froglet. Swamp Sclerophyll Forest also provides potential habitat for Koala, which feeds on a selection of preferred eucalypt species including Swamp Mahogany.

Wetland habitats

A range of freshwater wetland types occur in floodplain areas throughout the project boundary. These comprise both permanent and ephemeral wetlands of varying condition and character. For example, relatively natural paperbark swamp forest, Swamp Mahogany swamp forest, and sedgeland wetlands occur, as do open lagoons in cleared agricultural areas, and grazed ephemeral reed and sedge areas.

Species dominating the upper strata include Lepironia (*Lepironia articulata*) and Common Reed (*Phragmites australis*). Jointed Baumea (*Baumea articulata*), Common Baumea (*Baumea rubiginosa*) and Tall Knotweed (*Persicaria lapathifolium*) are also common occurrences. Bungwahl Fern (*Blechnum indicum*) and Bristly Knotweed (*Persicaria strigosa*) dominate the lower strata, with Swamp Rice Grass (*Leersia hexandra*), Rough Ground Fern (*Hypolepis muelleri*) and also Triglochin (*Triglochin procerum*) commonly occurring.

These freshwater wetland habitats offer foraging, shelter, roosting and breeding habitat for a range of fauna. Common fauna include frogs, fish, turtles, waterbirds and a diversity of micro- and macro-invertebrates. The frog families represented are Myobatrachidae (southern frogs) and Hylidae (tree frogs), including the threatened Green and Golden Bell Frog. Freshwater wetland habitat provides potential breeding sites for local populations of waterbirds as well as habitat for migratory birds. Threatened or migratory waterbirds which use wetland habitat within the study area include Black-necked Stork, Latham's Snipe and Comb-crested Jacana. These areas are also important for threatened frog species such as Wallum Froglet and Olongburra Frog, and Oxleyan Pygmy Perch.

Wet and dry heath habitat

Heath-Sedgelands are floristically rich and adapted to a 7 to 10 year mosaic burn fire regime. In the project boundary this habitat type occurs as a heath and shrubland with occasional stunted trees to 10 metres high. Dominant species include Heath Banksia (*Banksia oblongifolia*), Swamp Grasstree (*Xanthorrhoea fulva*) and White Paperbark (*Melaleuca sieberi*), with occasional emergent trees including Scribbly Gum, Broad-leaved Paperbark and Ball Honeymyrtle (*M. nodosa*). The ground layer comprises leaf litter and bare ground. Heath-sedgelands have been extensively cleared for urban development, and many once continuous areas of habitat now occur as a matrix of smaller patches in areas of rapid urban expansion.

Heath-sedgeland habitat provides habitat for a range of terrestrial fauna groups, including frogs, reptiles, nectivorous birds and small terrestrial mammals. Threatened species considered likely to occur include Wallum Froglet and Wallum Sedgefrog. Emergent trees, banksias and paperbarks within this habitat may also provide foraging habitat for Squirrel Glider and Grey-headed Flying-fox. The Ground Parrot also relies on heath-sedgeland and

the mosaic fire regime which creates a mix of regenerating and mature heathland habitat.

Lowland rainforest

Lowland rainforest is typically highly structurally diverse and productive, providing a range of habitat opportunities for fauna. These areas support hollow-bearing trees, and year-round flowering and fruiting plants, providing a reliable food source for terrestrial and arboreal animals, including a range of native pigeons and doves.

The dominant tree cover consists of Bangalow Palms (*Archontophoenix cunninghamiana*), Turpentine (*Syncarpia glomulifera*), Swamp Turpentine (*Lophostemon suaveolens*) and Paperbarks (*Melaleuca* spp.). The ground layer is sparse with ferns, *Lomandra* spp., *Gahnia* spp. and Cordyline most prominent. Vines and epiphytes are common.

Species that prefer moist forest habitats, including rainforest, are fruit-dove species, Sooty Owl, Giant and Stuttering Barred Frogs, Golden-Tipped Bat, Common Blossom Bat and Stephen's Banded Snake. Other threatened species within adjoining vegetation communities could also make use of the rainforest remnant at least on a seasonal basis.

Cleared and modified habitats

Modified communities are defined as former forest associations which have been modified through land clearing and draining for the development of farm land and now exist as introduced pasture, remnant trees with a grassy pasture understorey or regrowth forest either of the same origin or different species. These areas include cleared pasture with scattered trees, plantation, cropland, market garden, pine forest and cleared open pasture.

Small isolated fragments of the former forest communities often occur with an understorey dominated by introduced pasture or weeds. Occasional remnant paddock trees have been retained in the landscape. Cleared cropping land comprises mostly sugar cane farms and introduced pasture grasses. Such areas contain limited remnant vegetation and are characterised by a generally low native floral diversity. Commonly, scattered remnant trees and small fragmented native vegetation patches are present, as are planted areas for windbreaks and landscaped gardens. The areas are dominated by introduced pasture grasses, including Paspalum (*Paspalum dilatatum*) and Kikuyu (*Pennisetum clandestinum*).

Although these areas are heavily modified environments, they do provide habitat for some fauna. Some microchiropteran bats are known to forage and may roost in scattered paddock trees and forest and woodland remnants (Lumsden and Bennett 2004), while owls and other predatory birds may frequent cane fields for foraging.

3.5.2. Forest habitat condition

Forest habitat condition was generally high throughout the study area. Hollow-bearing trees were recorded in most transects in all habitat types and project sections irrespective of broad vegetation community type. Food resources for the Glossy-black Cockatoo (*Allocasuarina torulosa* and *A.littoralis*) were present at many sites, and abundant fallen wood was common (Table 3-6). Canopy cover and canopy height were relatively similar across all broad vegetation communities in the study area. The dry heath community was

the exception. This community was included in the assessment because it occurs in the study area and has some habitat value as a foraging resource for a number of forest fauna. However, it is not forest vegetation, so it was excluded from further analysis.

Table 3-6: Comparison of habitat characteristics between broad vegetation types

Habitat type	Number of hollow-bearing trees in plot (0.1 hectares) (average ± SE)	Mean log lengths (m ± SE)	Allocasuarina (relative density)	Mean canopy height (m ± SE)	Mean canopy cover (%± SE)
Dry forest habitat (clay soils)	7.64 (6.80)	77.60 (44.45)	22	25.37 (4.80)	37.42 (14.92)
Dry forest habitat (sandy soils)	4.70 (3.83)	73.51 (45.10)	46	24.08 (5.51)	38.63 (18.28)
Heath habitat	0 (0)	5.40 (9.40)	0	7.00 (0)	65.00
Moist forest/riparian habitat	7.00 (3.83)	79.40 (36.76)	2	25.70 (5.14)	33.00 (31.54)
Floodplain eucalypt forest habitat	2.87 (2.20)	40.47 (35.52)	8	21.10 (5.83)	46.87 (17.03)
Swamp forest habitat	2.85 (3.07)	50.54 (54.47)	10	22.40 (7.09)	47.42 (14.54)

Hollow-bearing tree density and log lengths

The highest densities of hollow-bearing trees, and the most logs on the ground were recorded in the clay and sandy dry forests, and in moist floodplain forest. These features are important for hollow-dependent arboreal mammals and birds, such as large forest owls and gliders, and ground-dwelling mammals such as Rufous Bettong and Brush-tailed Phascogale. These figures suggest that an average of between 28-76 hollow-bearing trees occur per hectare in habitats along the project boundary.

Forest successional stage

Most of the sites in each broad vegetation community type were regenerating, except for sub-tropical floodplain forest and swamp forest (Figure 3-32). There was more mature forest in the study area for these broad vegetation community types. A great proportion of the clay dry forest and sandy dry forest types were regenerating, than any of the other broad vegetation communities assessed. This is because these communities are mostly managed for timber production in the study area. There was proportionally more mature swamp forest and sub-tropical coastal floodplain forest in the study area because these communities largely exist in the landscape as remnants along watercourses, and in areas too wet for production.

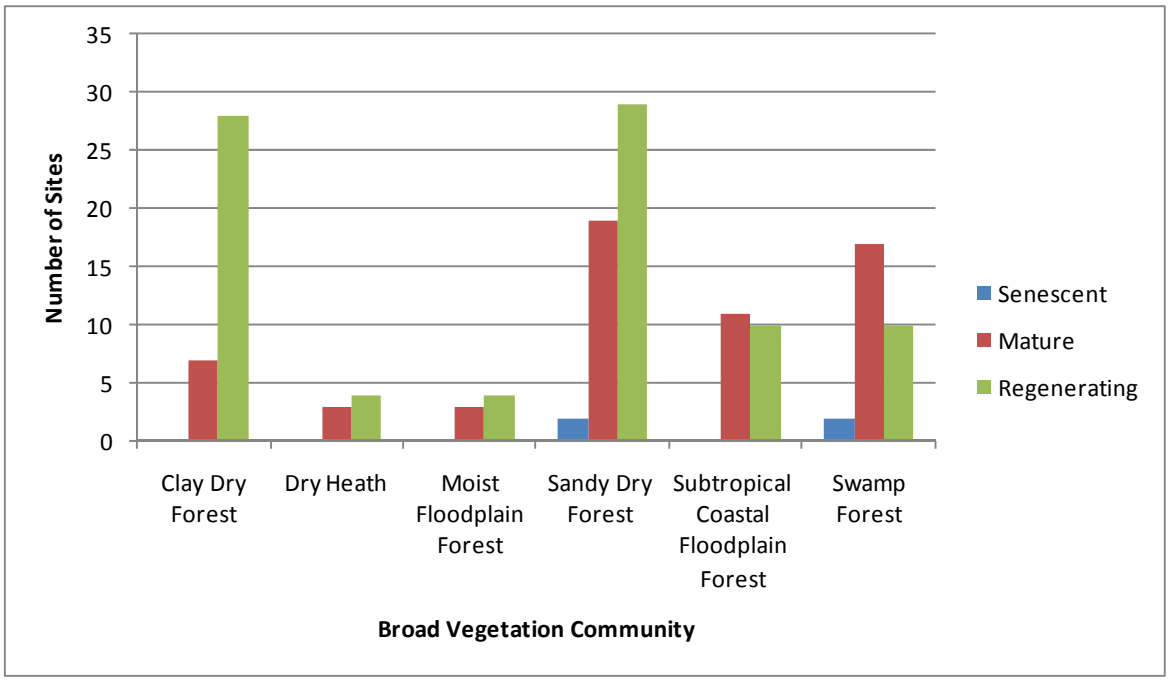

Figure 3-32: Comparison of successional stage for each broad vegetation community type in the study area

Successional stage of the forest is influential in habitat condition for forest fauna because it is indicative of the potential for hollow-bearing trees, fallen timber on the forest floor, and for productive, flowering trees which are a foraging resource. Forest areas which support a combination of mature and regenerating stages offer a range of opportunities for foraging, refuge and nesting for birds, and arboreal and ground-dwelling mammals. Mature forests are also more likely to support optimum leaf litter and soil conditions, which contributes to invertebrate biodiversity as a foraging resource for small mammals.

Allocasuarina in the study area

Allocasuarina is an important foraging resource for Glossy-black Cockatoo (*Calyptorhynchus lathami*), a listed vulnerable species under the TSC Act. This species forages on *Allocasuarina* seeds and nests in hollows, so it is reliant on mature forest habitats in the study area for breeding and foraging.

Allocasuarinas were found in all broad vegetation communities in the study area (Figure 3-33). Of these though, the highest densities of *Allocasuarina* were encountered in dry forests (sandy and clay soils).

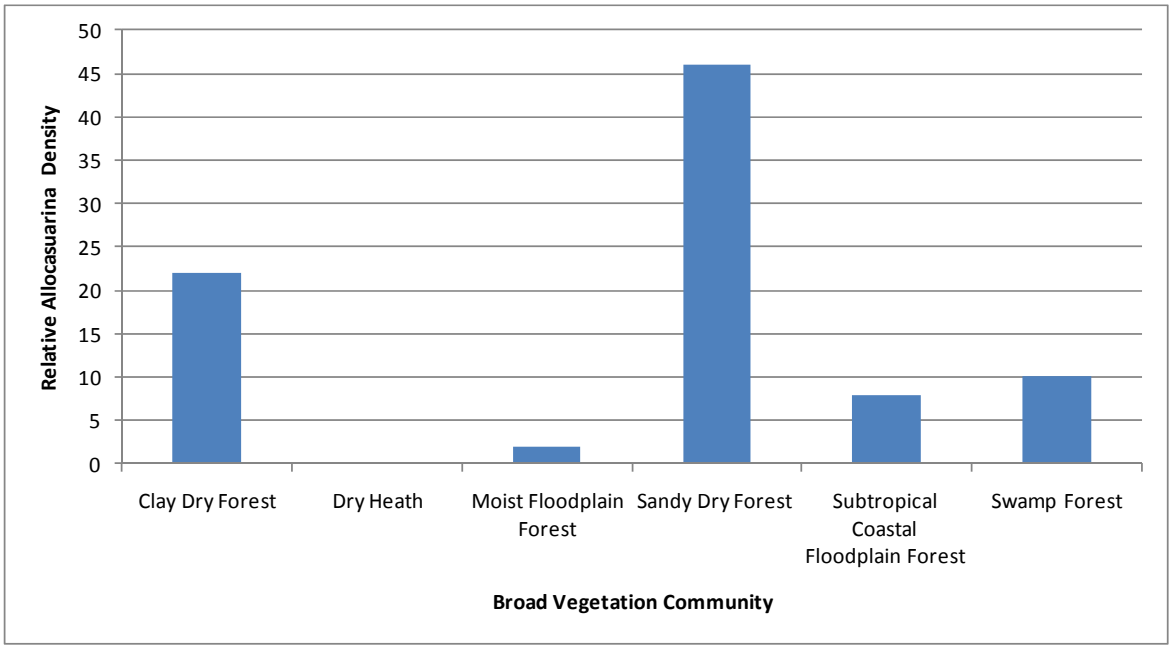

Figure 3-33: Comparison of relative density of Allocasuarina between the broad vegetation communities.

Overall habitat value

The results for log length, density of hollow-bearing trees, forest successional stage, presence of *Allocasuarina*, canopy height and canopy cover were combined to create an index of overall habitat value for forest fauna across all broad vegetation communities in the study area (refer to Table 3-7).

The index was created by assigning each habitat descriptor a score between one and three according to whether the value for each broad vegetation community was the highest of all, the lowest of all, or in-between. Similarly the sum of the scores across broad vegetation communities was used to determine overall habitat value. The two highest scores were assigned ‘high’ habitat value, the two lowest were assigned ‘low’ value and those in-between were assigned ‘moderate’ habitat value. Note, however, that this is a relative scoring intended only for the purposes of mapping areas of habitat value for hollow-dependent and ground-dwelling fauna, and Glossy-black Cockatoo habitat value, across the study area. The different forest types in the study area hold a range of values for a wider range of flora and fauna (such as amphibians) than is represented here.

When all the habitat descriptors were combined, the clay and sandy dry forest communities ranked highest in terms of overall habitat value to forest fauna. These communities typically supported higher densities of hollow-bearing trees and fallen logs, and higher densities of *Allocasuarina*.

Table 3-7: Ranking used to create the fauna habitat value index

Habitat type	Habitat descriptor				Overall habitat value
	Hollow-bearing trees	Log length	Allocasuarina	Canopy cover	
Dry forest on clay soils	High	High	Moderate	Moderate	HIGH
Dry forest on sandy soils	Moderate	High	High	Moderate	HIGH
Moist/ riparian forest	High	High	Low	Moderate	MODERATE
Swamp forests	Low	Moderate	Moderate	High	LOW
Floodplain forest	Low	Moderate	Moderate	High	LOW

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Legend sheet B

Threatened fauna species

Bird

- Australasian Bittern
- Black-necked Stork
- Black-chinned Honeyeater
- Brolga
- Brown Treecreeper
- Bush Stone-curlew
- Emu
- Glossy Black-cockatoo
- Grass Owl
- Grey-crowned Babbler
- Magpie Goose
- Masked Owl
- Osprey
- Powerful Owl
- Rose-crowned Fruit-dove
- Sooty Owl

Flying mammal

- Common Blossom-bat
- Eastern Bent-wing Bat
- Eastern Cave Bat
- Eastern False Pipistrelle
- Eastern Long-eared Bat
- Grey-headed Flying Fox
- Hoary Wattled Bat
- Little Bent-wing Bat
- Southern Myotis

Non-flying mammal

- Brush-tailed Phascogale
- Common Planigale
- Koala
- Rufous Bettong
- Squirrel Glider
- Yellow-bellied Glider

Invertebrate

- Pink Underwing Moth
- Pink Underwing Moth - host plant
- Pink Underwing Moth and host plant
- Atlas Rainforest Ground Beetle

Frog

- Giant Barred Frog
- Wallum Froglet
- Green-thighed Frog

Reptile

- Stephens' Banded Snake

Fauna habitats

- Cleared and Modified
- Dry Forest
- Estuarine Wetland
- Freshwater Wetland
- Lowland Rainforest
- Swamp Forest
- Wet Sclerophyll and Floodplain Forest
- Wet and Dry Heath

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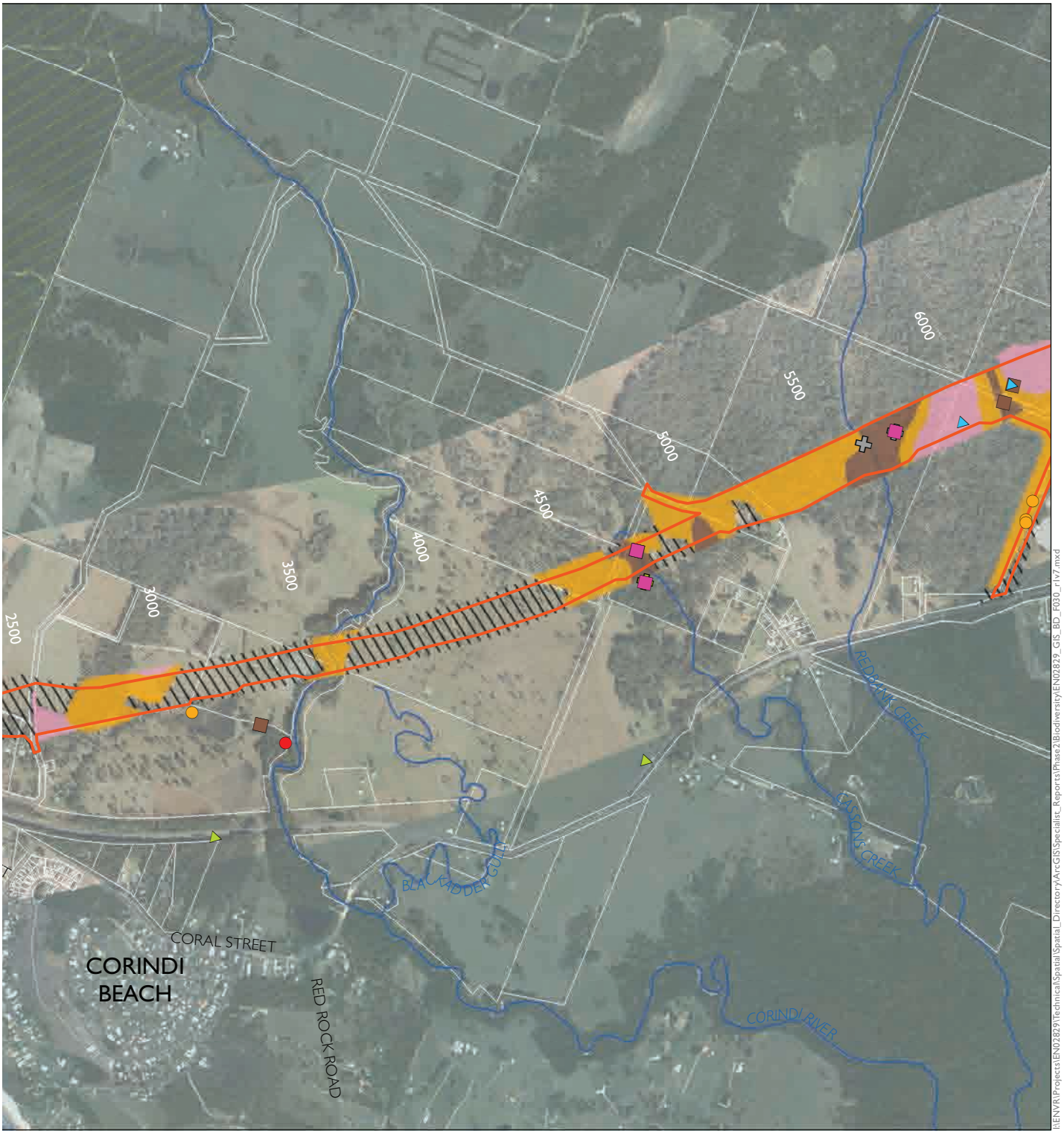
Figure 3 - 34 Fauna habitats and threatened fauna in the study area



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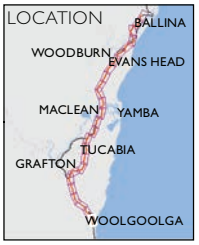
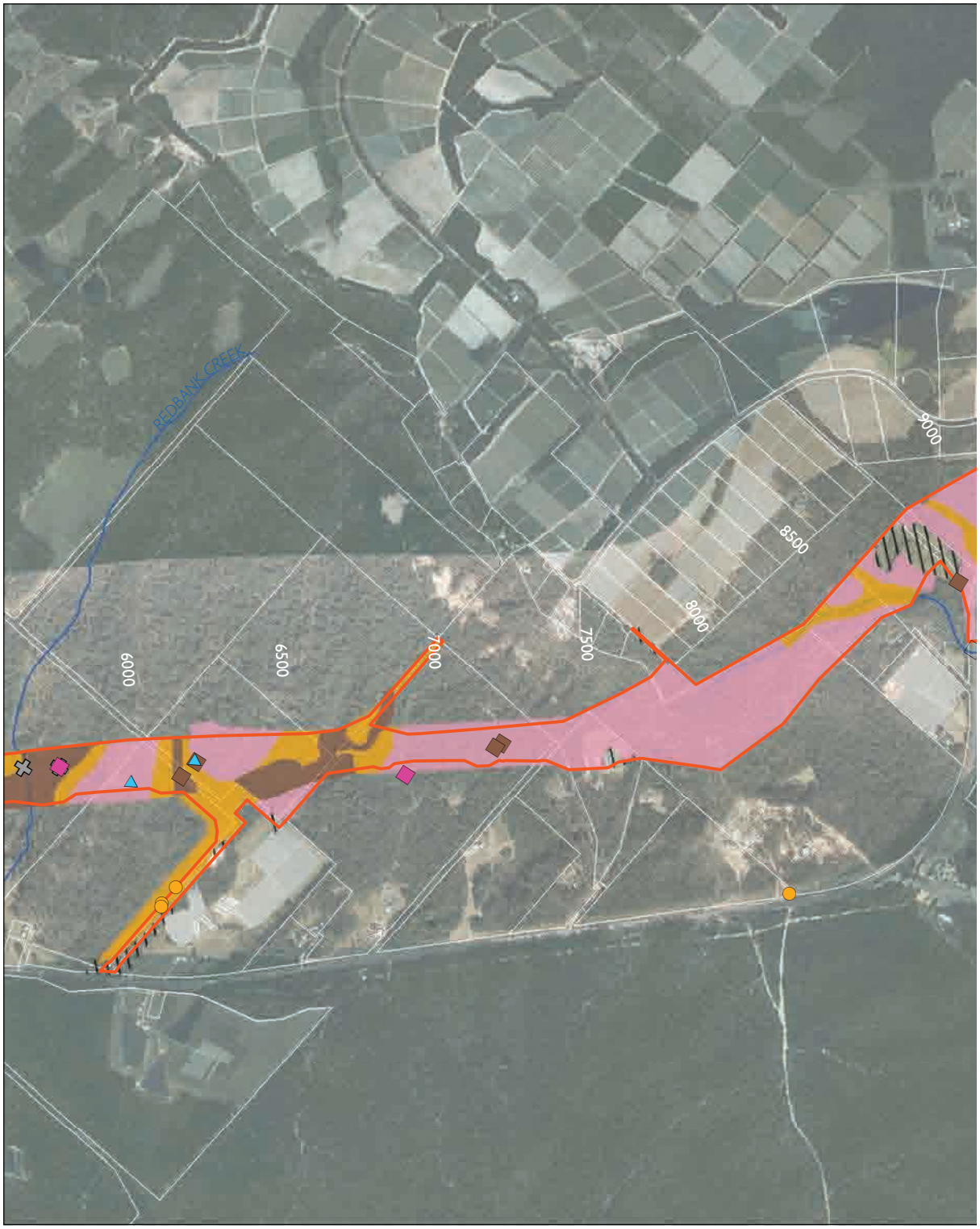
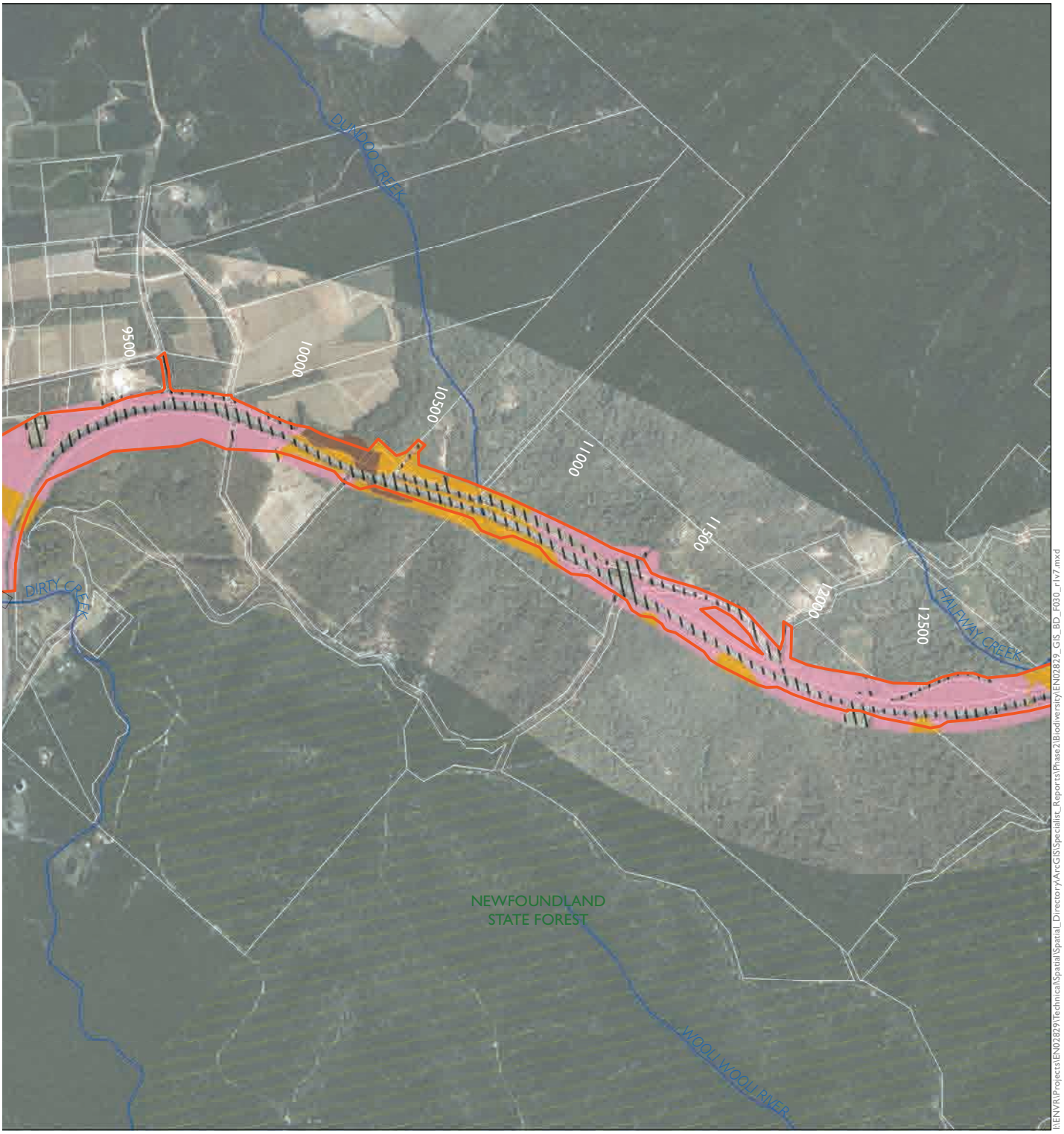


Figure 3 - 35 Fauna habitats and threatened fauna in the study area





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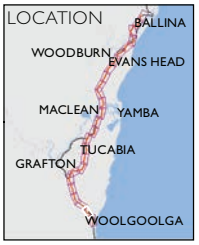
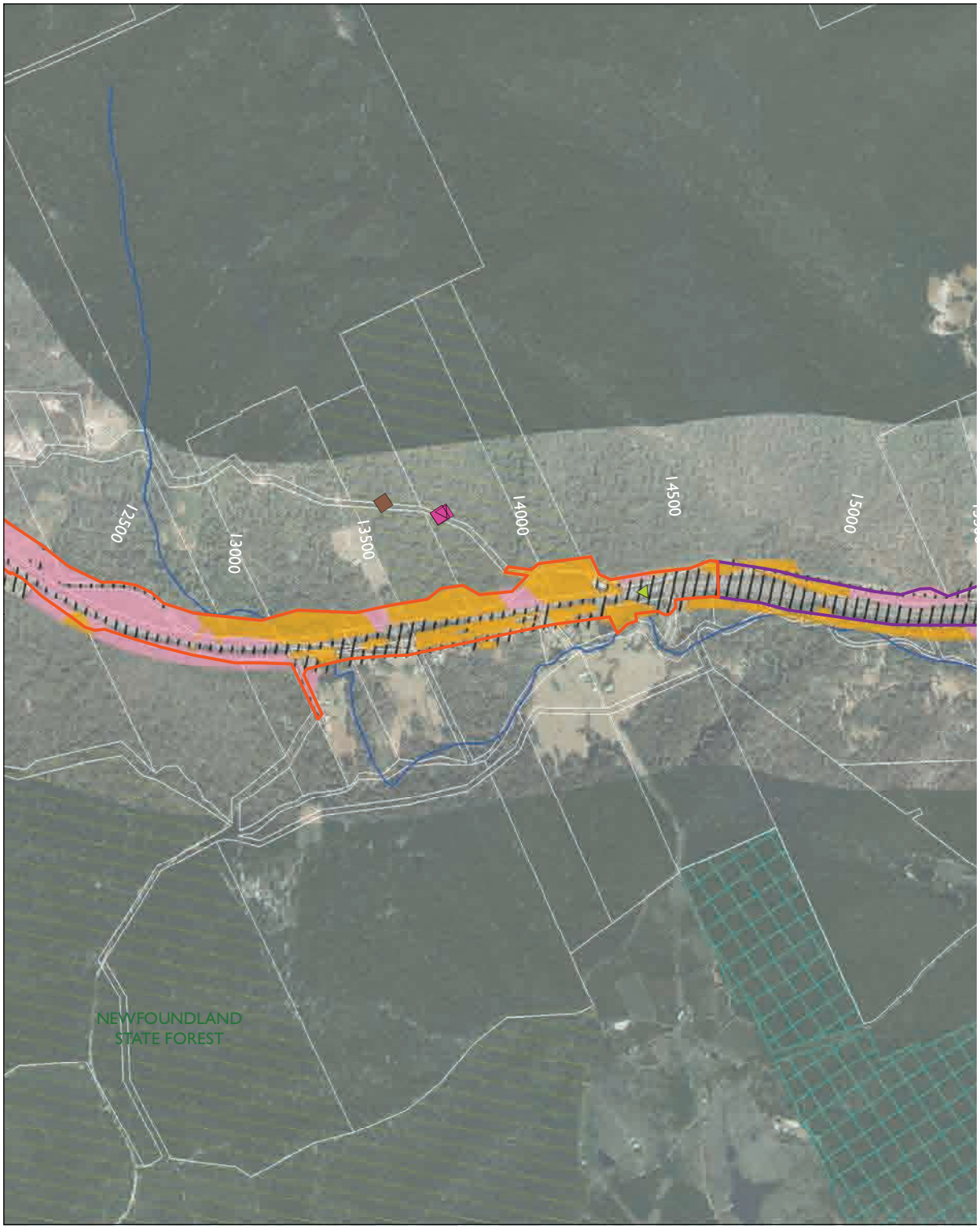


Figure 3 - 36 Fauna habitats and threatened fauna in the study area



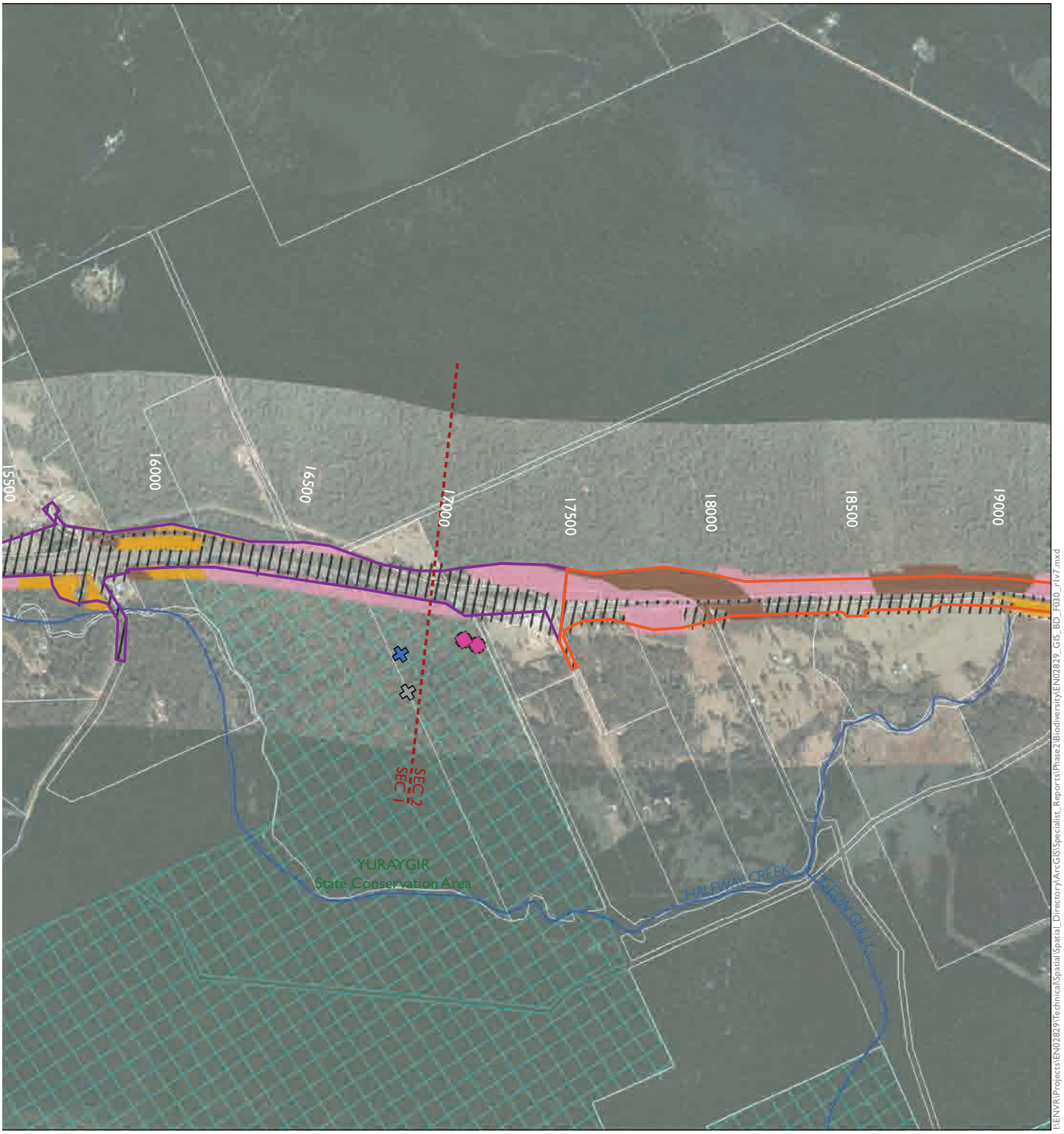


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Figure 3 - 37 Fauna habitats and threatened fauna in the study area

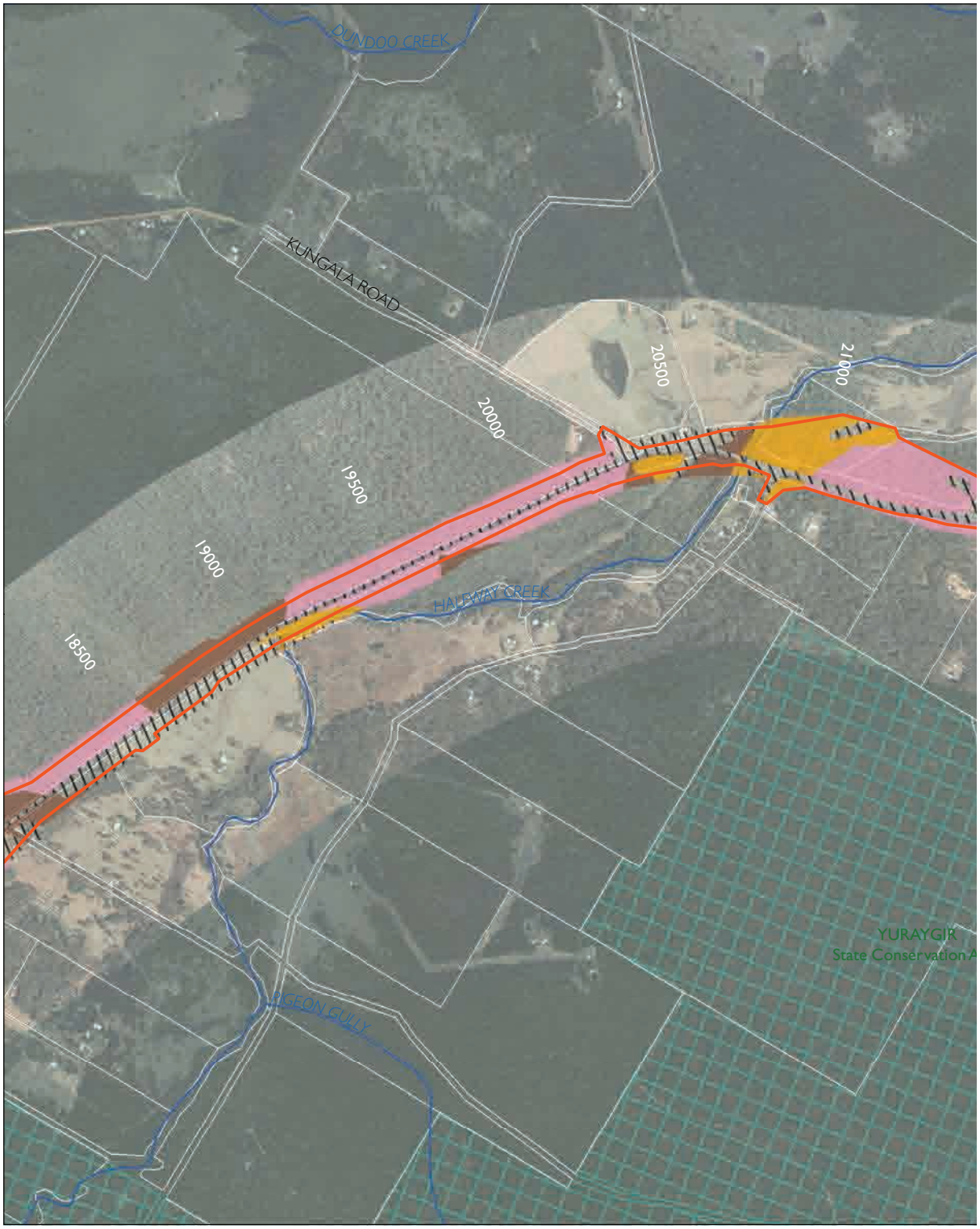

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Figure 3 - 38 Fauna habitats and threatened fauna in the study area

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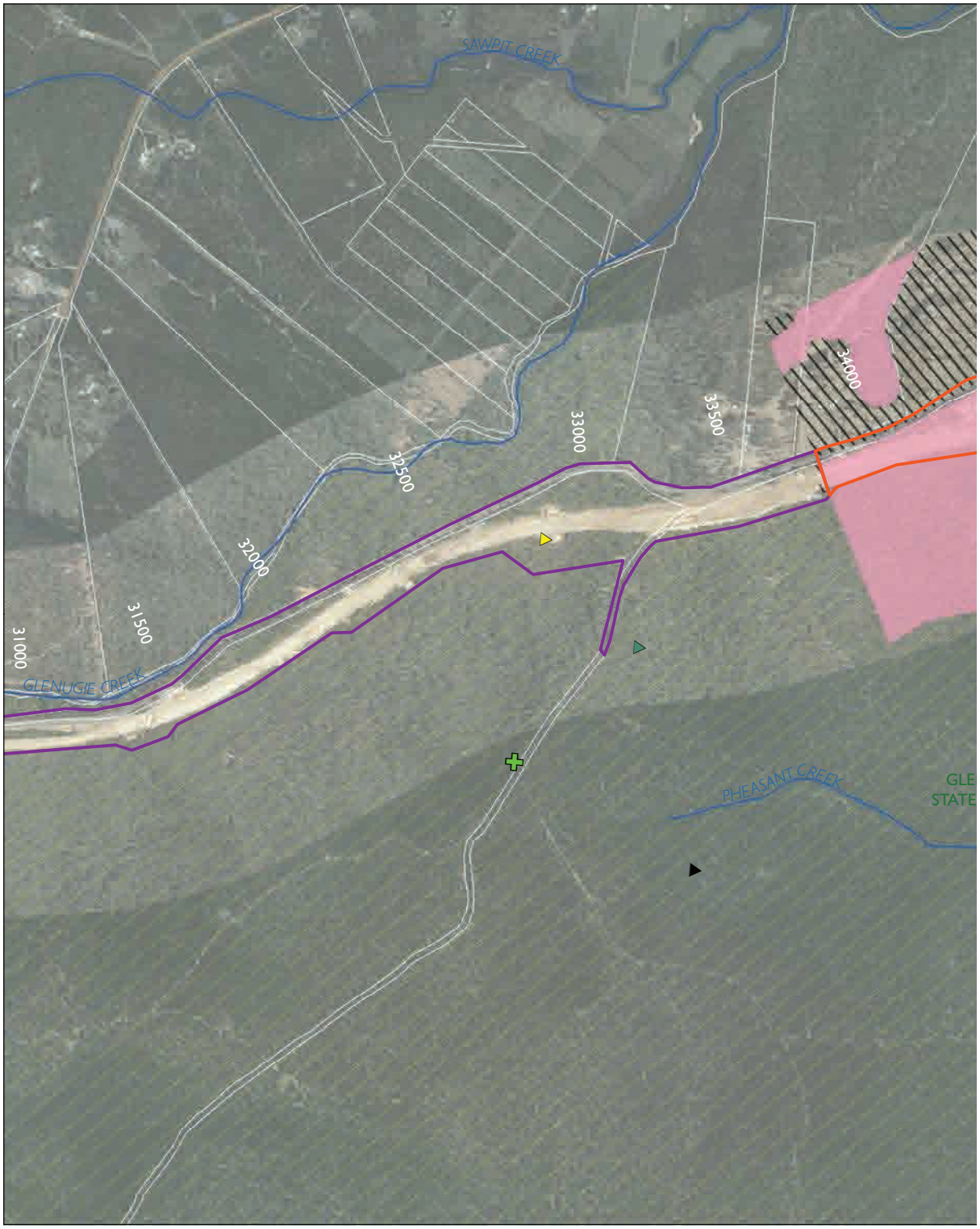
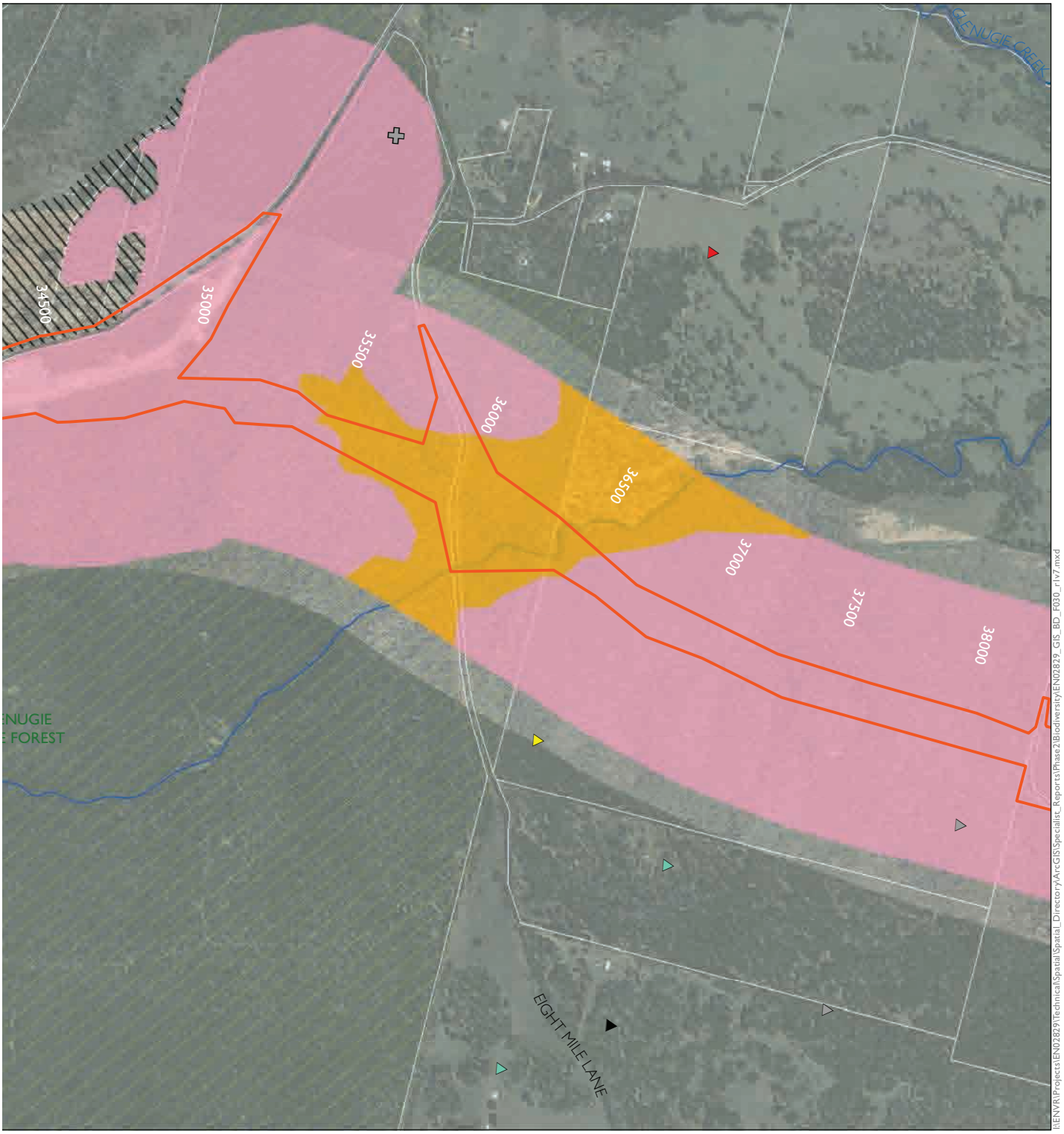
Figure 3 - 39 Fauna habitats and threatened fauna in the study area





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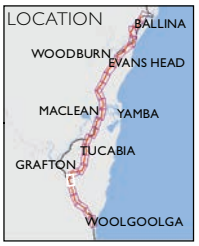
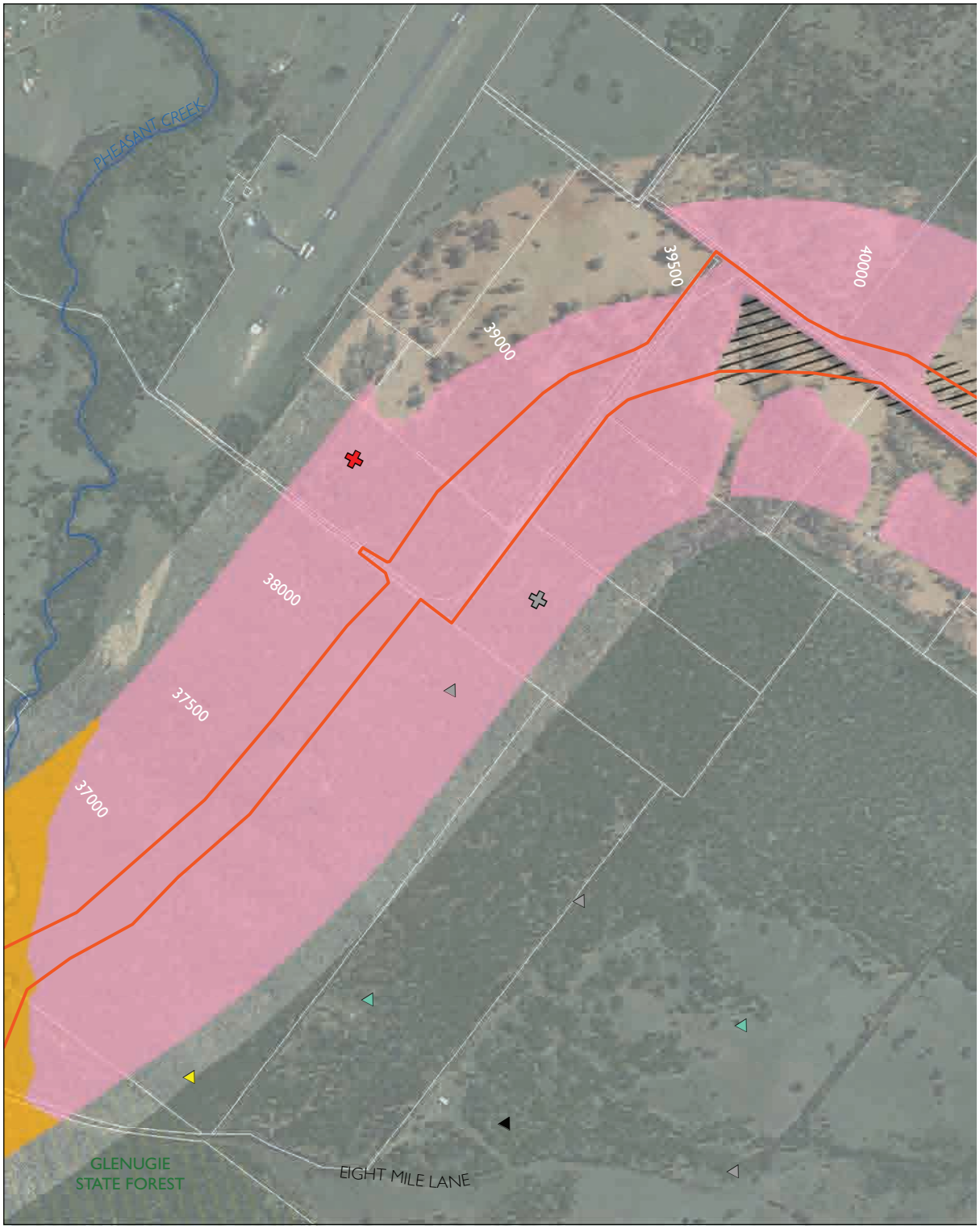
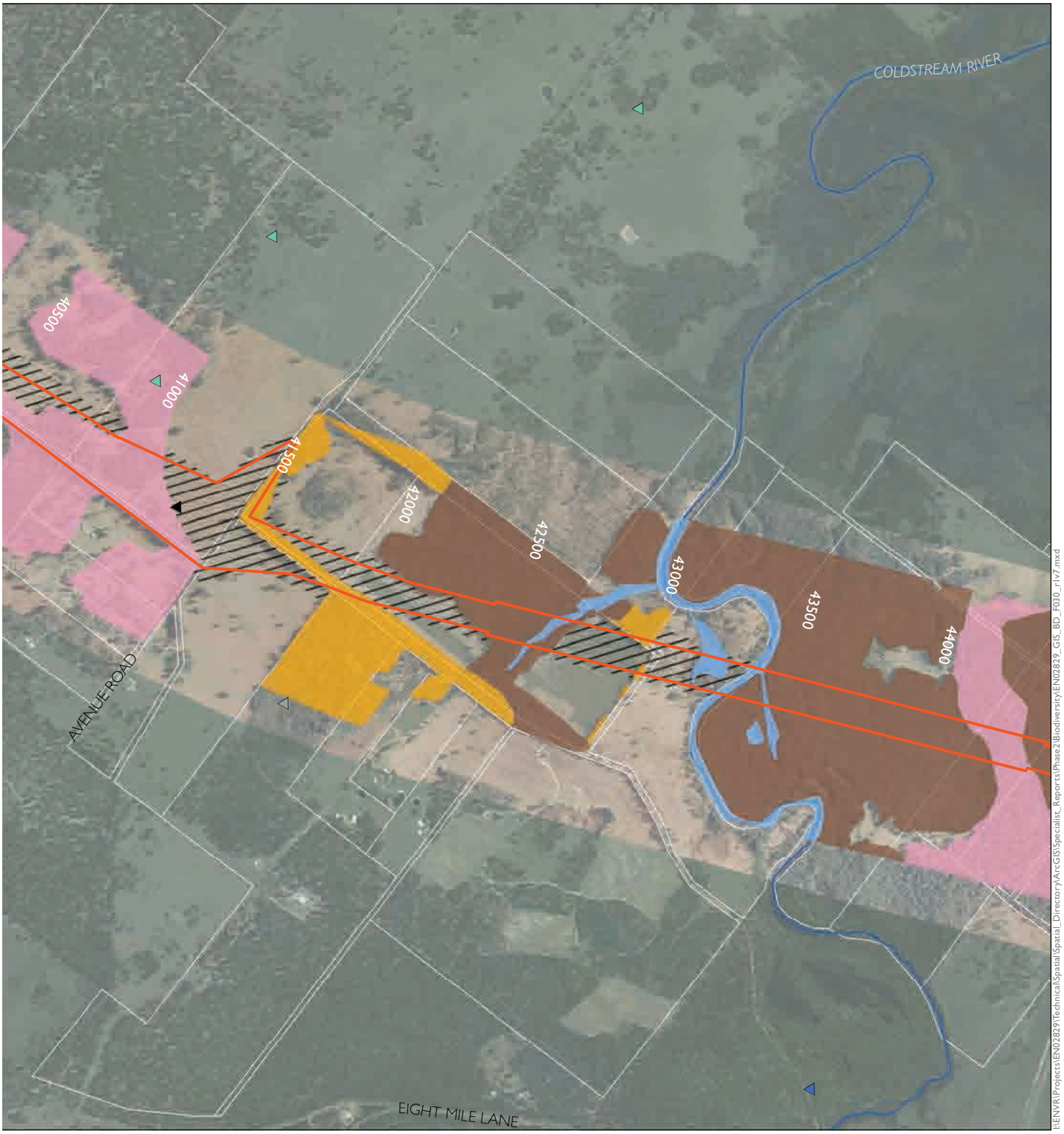


Figure 3 - 40 Fauna habitats and threatened fauna in the study area





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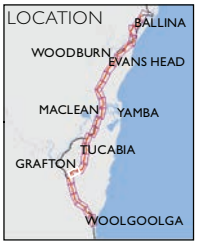
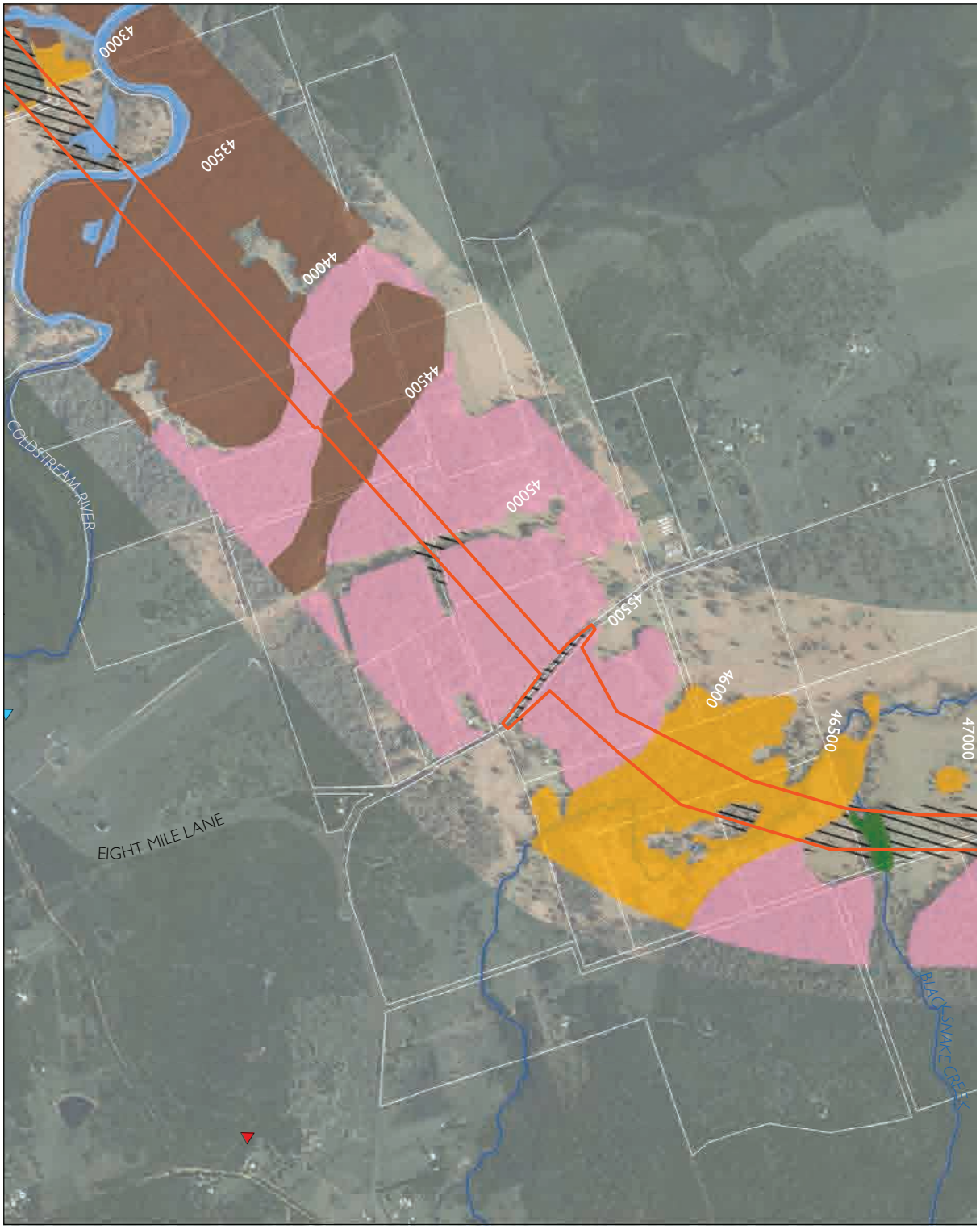


Figure 3 - 41 Fauna habitats and threatened fauna in the study area



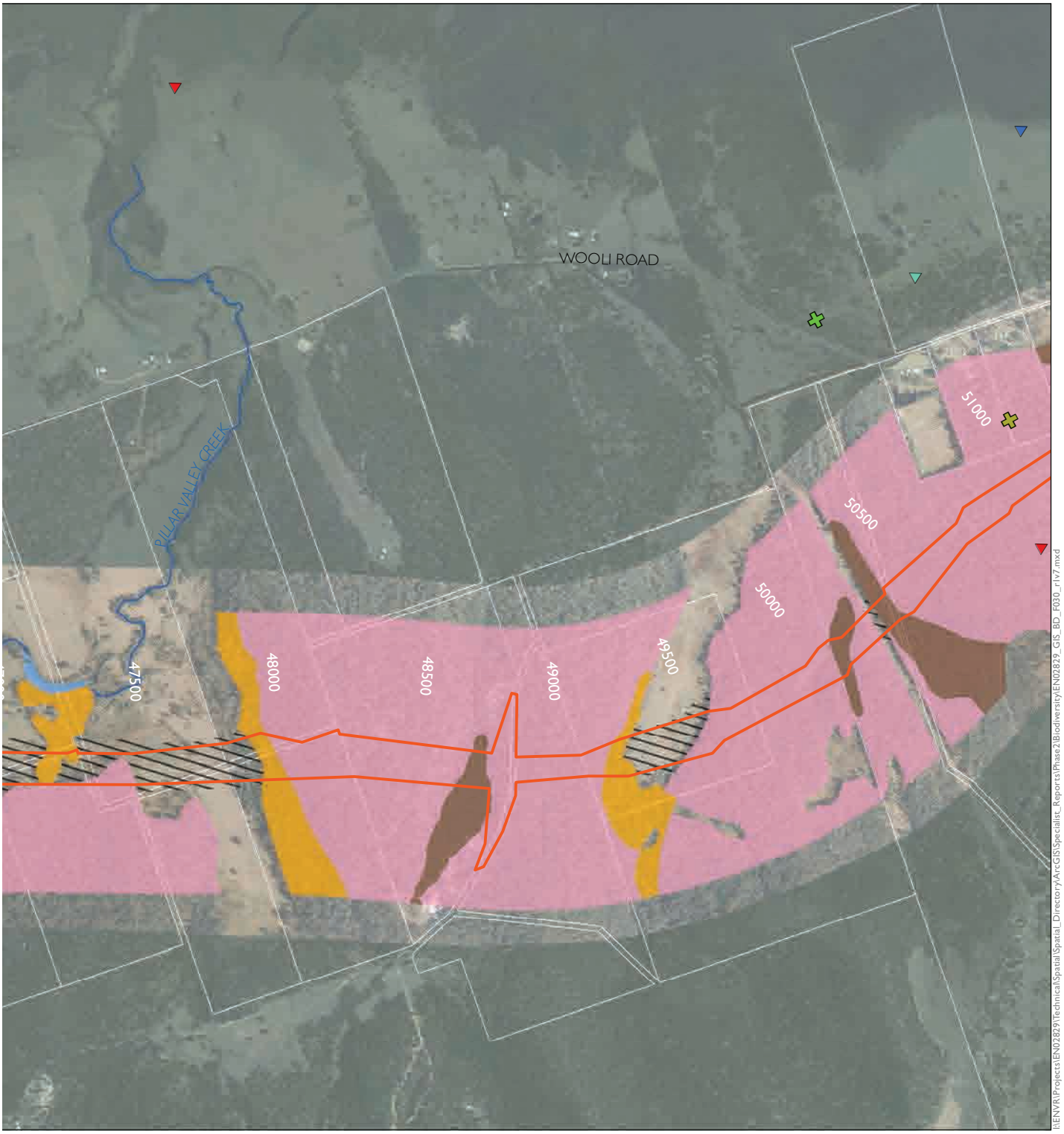


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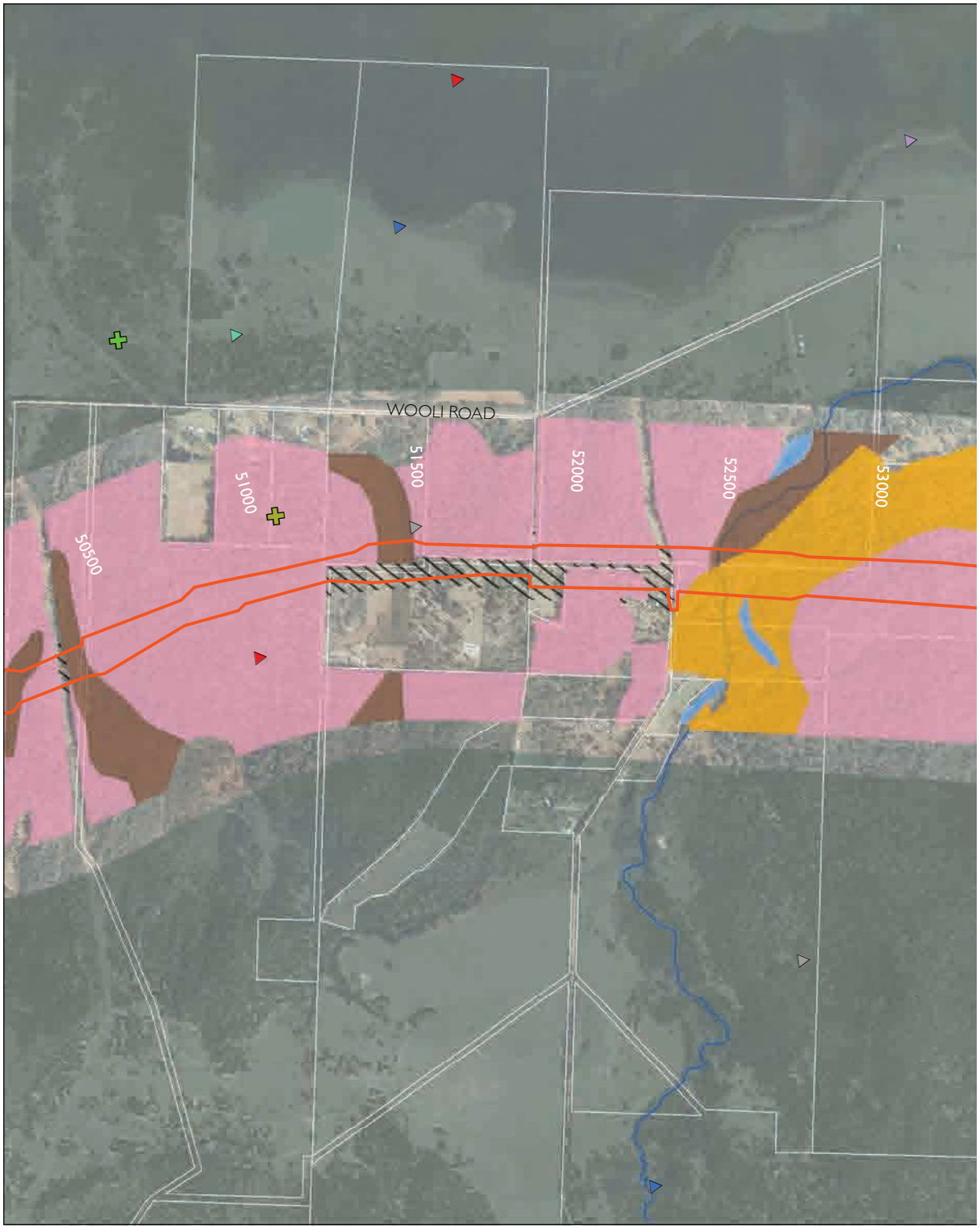
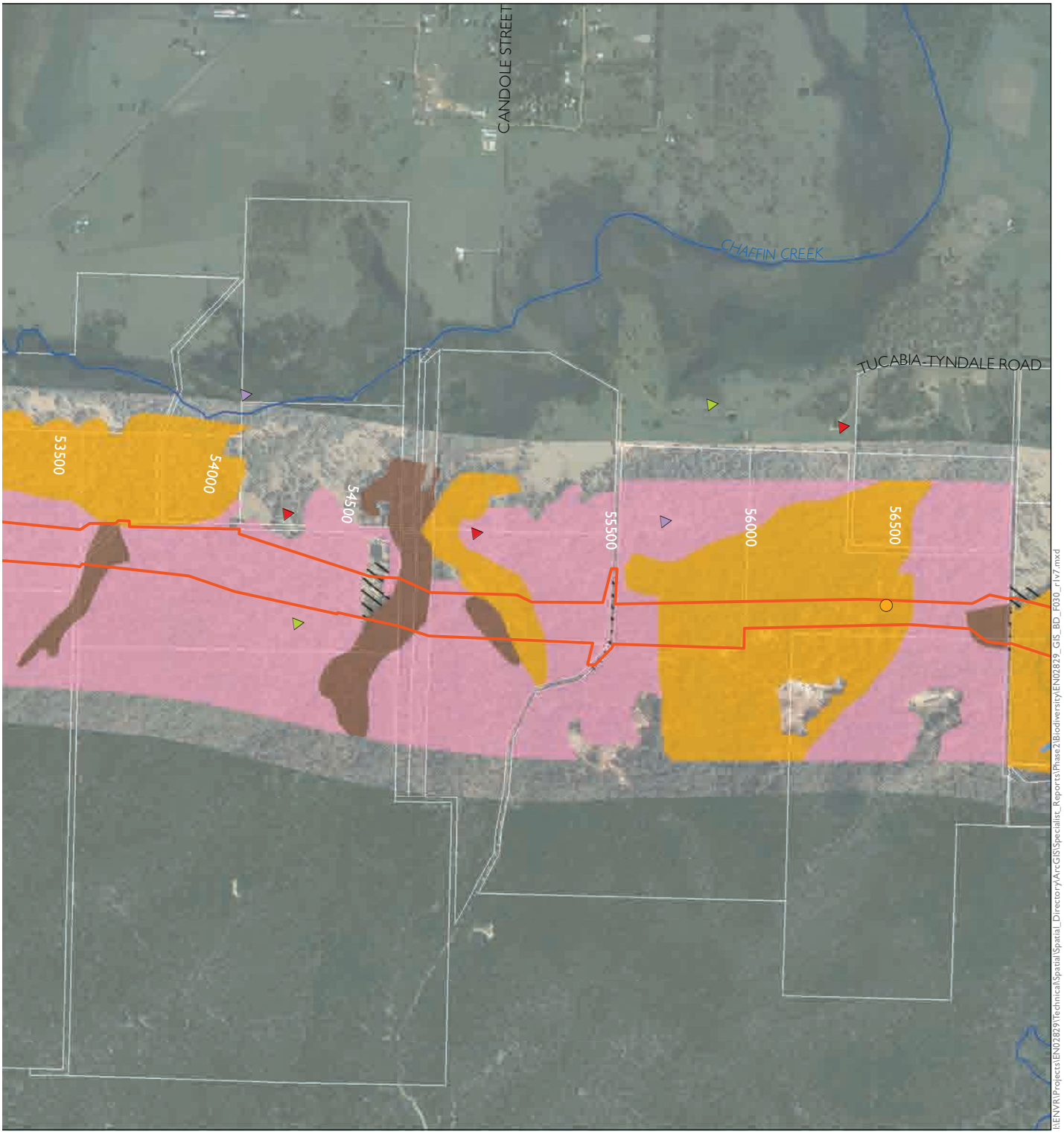
Figure 3 - 42 Fauna habitats and threatened fauna in the study area





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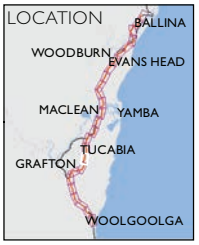

Figure 3 - 43 Fauna habitats and threatened fauna in the study area

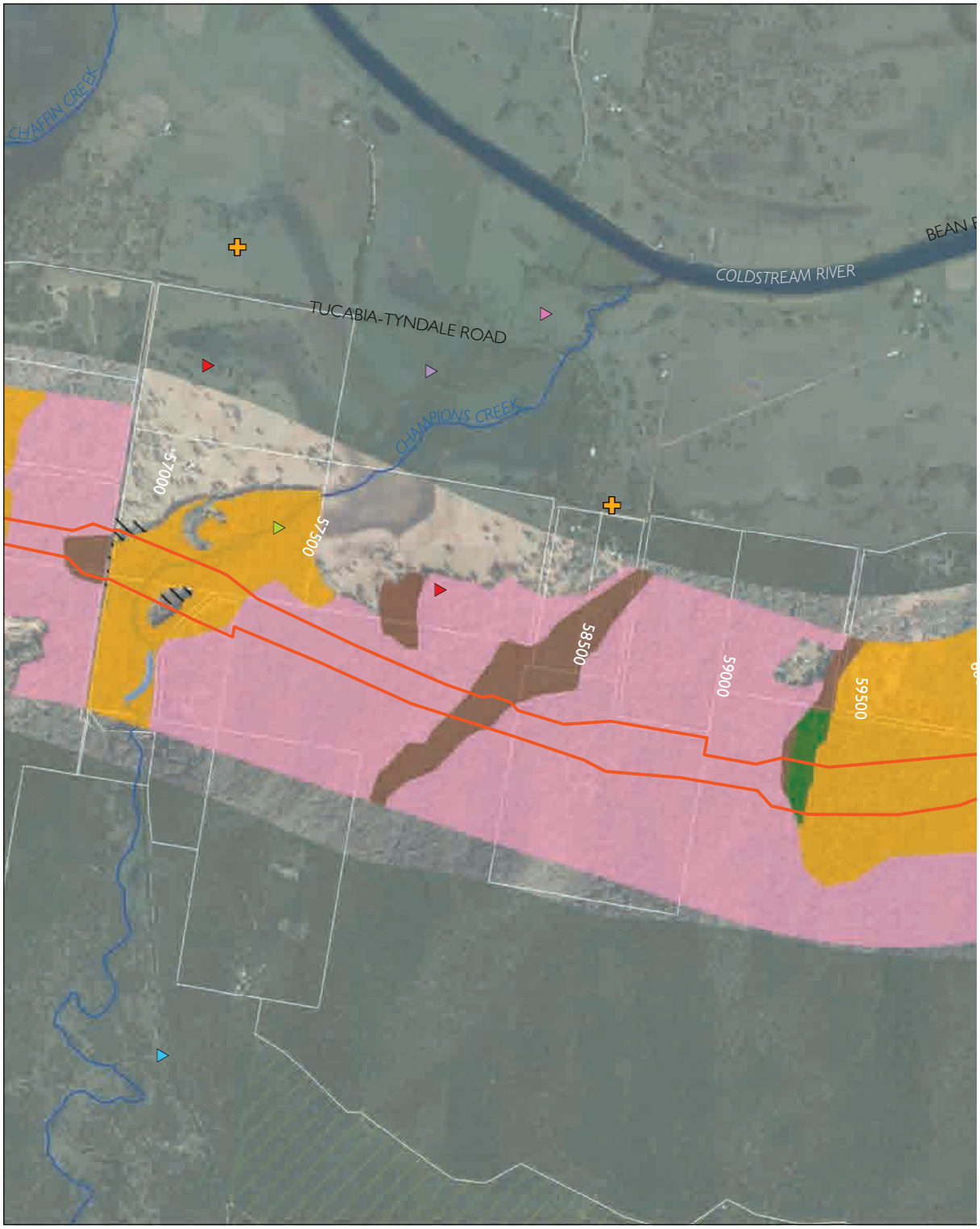

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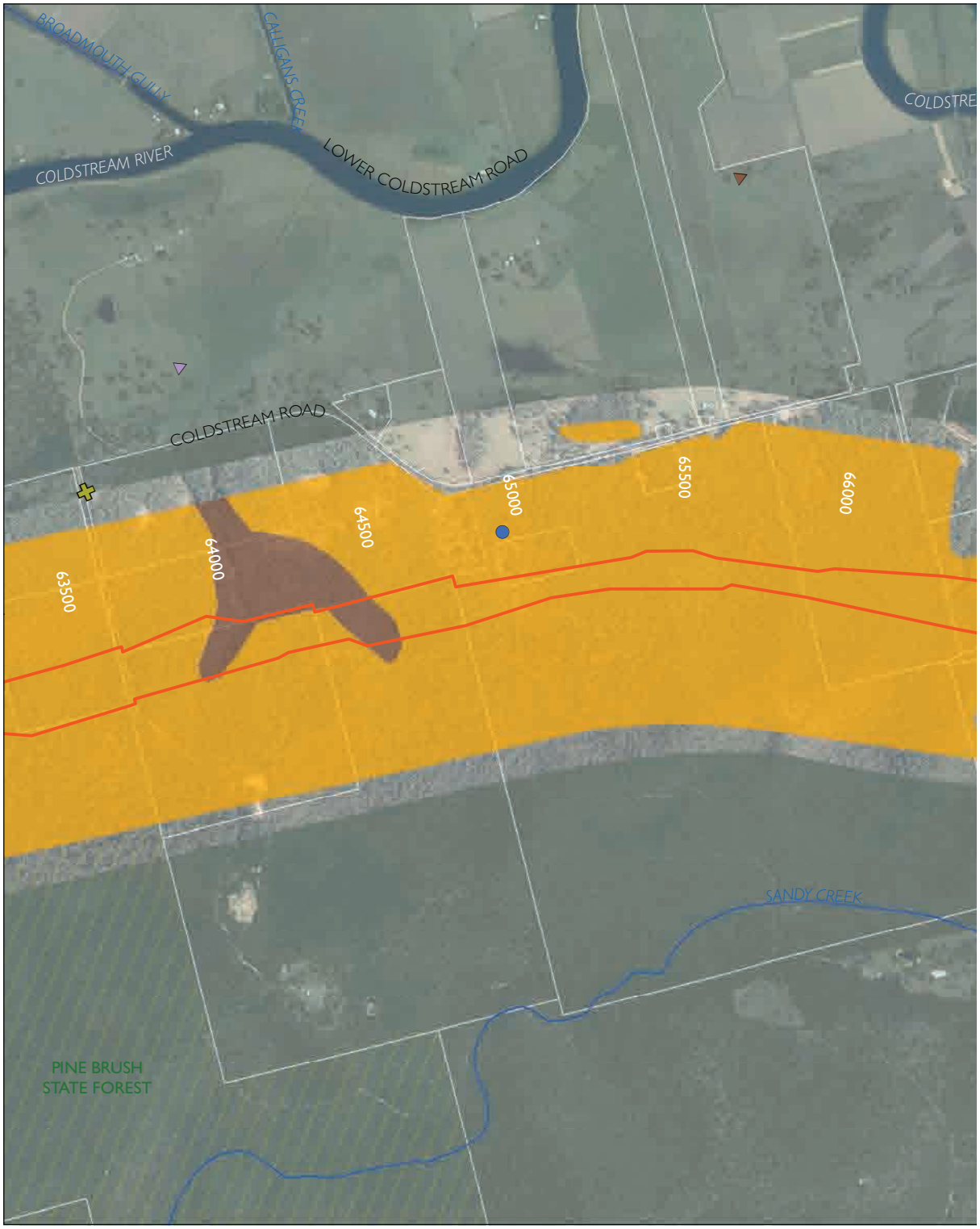
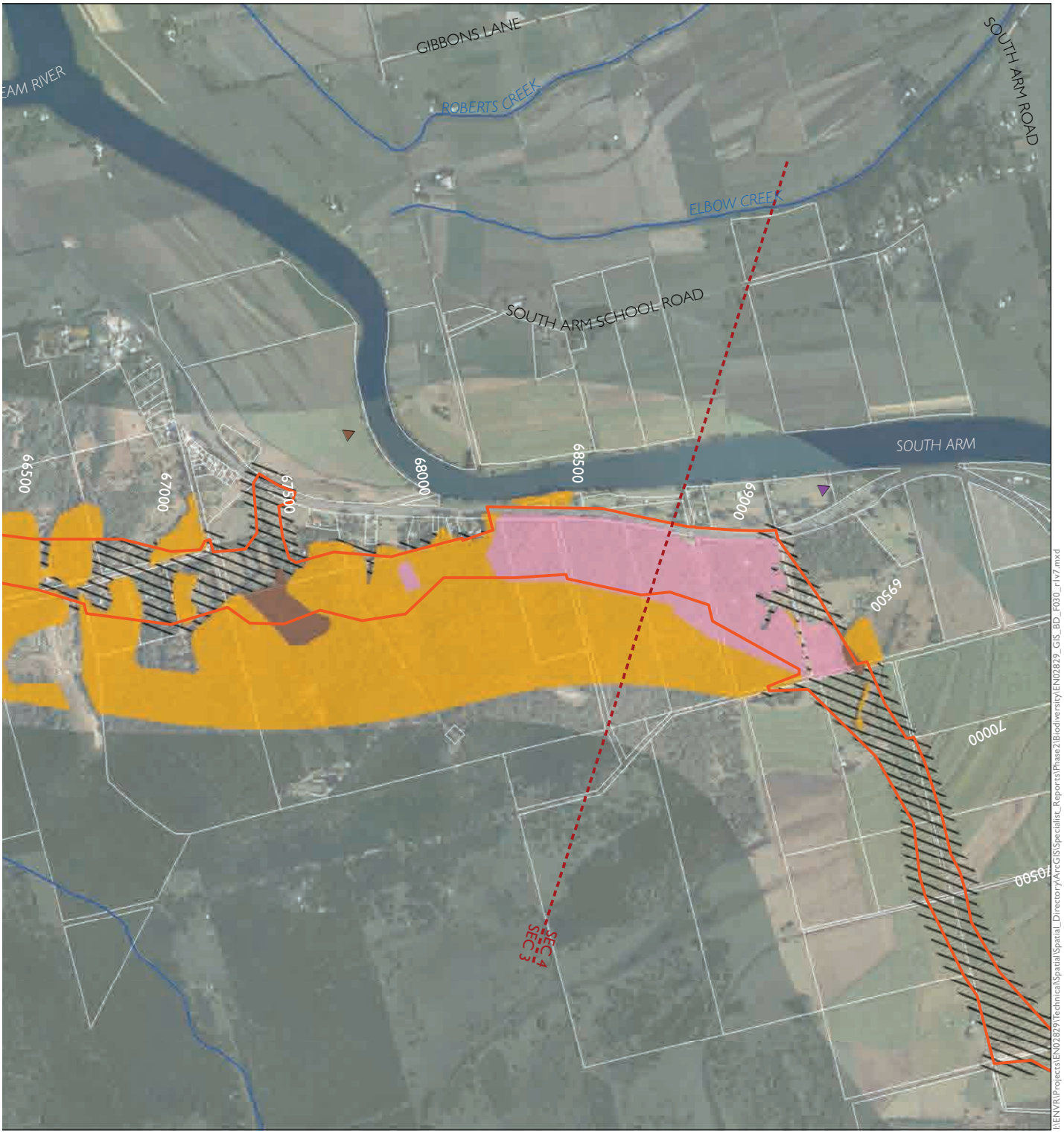
Figure 3 - 44 Fauna habitats and threatened fauna in the study area





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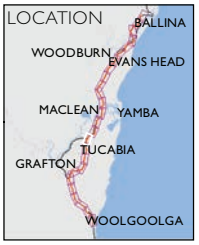
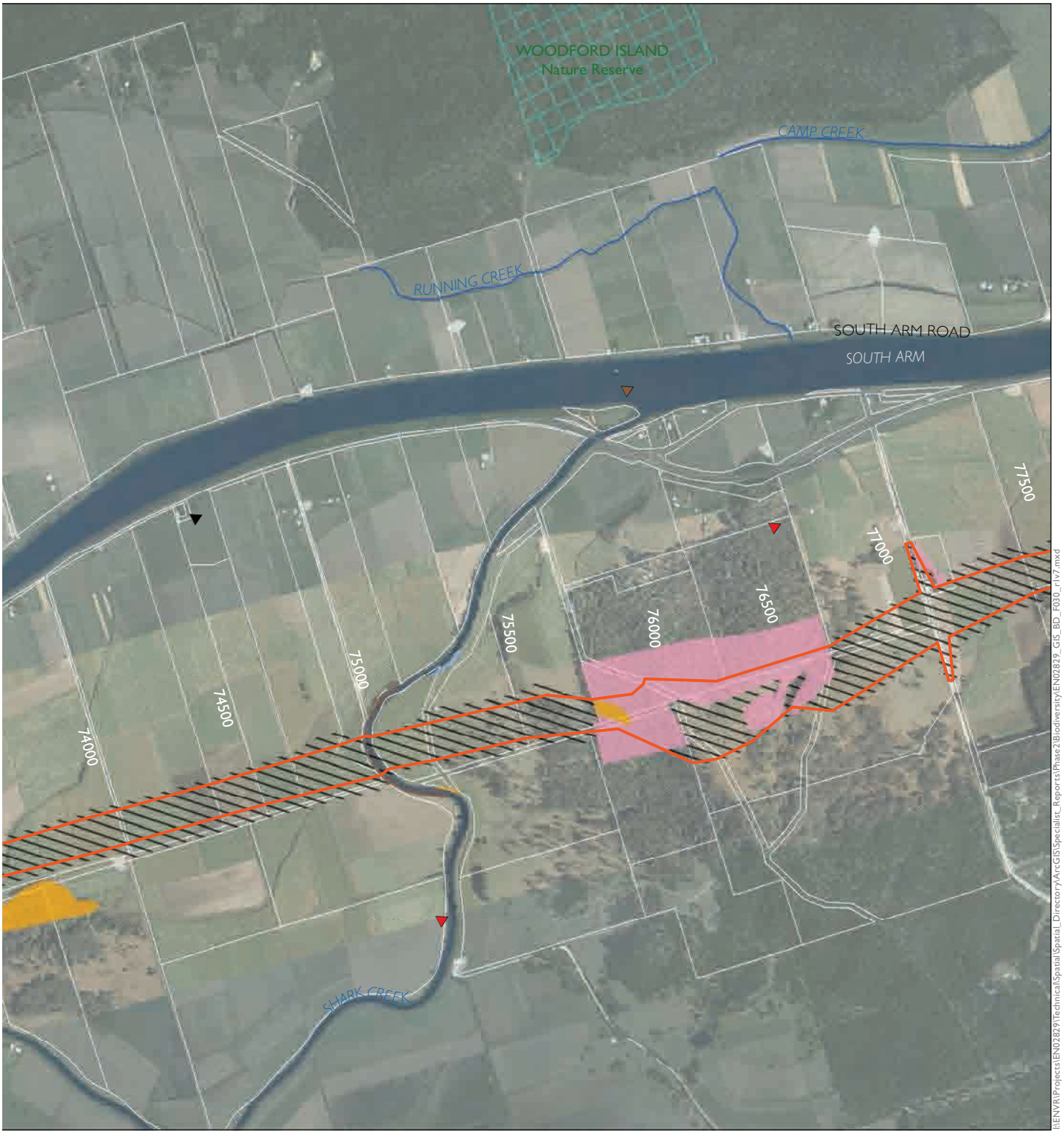


SHEET 11 of 26

Figure 3 - 45 Fauna habitats and threatened fauna in the study area



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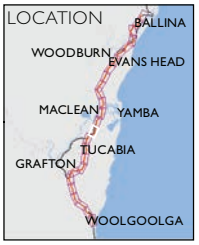

Figure 3 - 46 Fauna habitats and threatened fauna in the study area

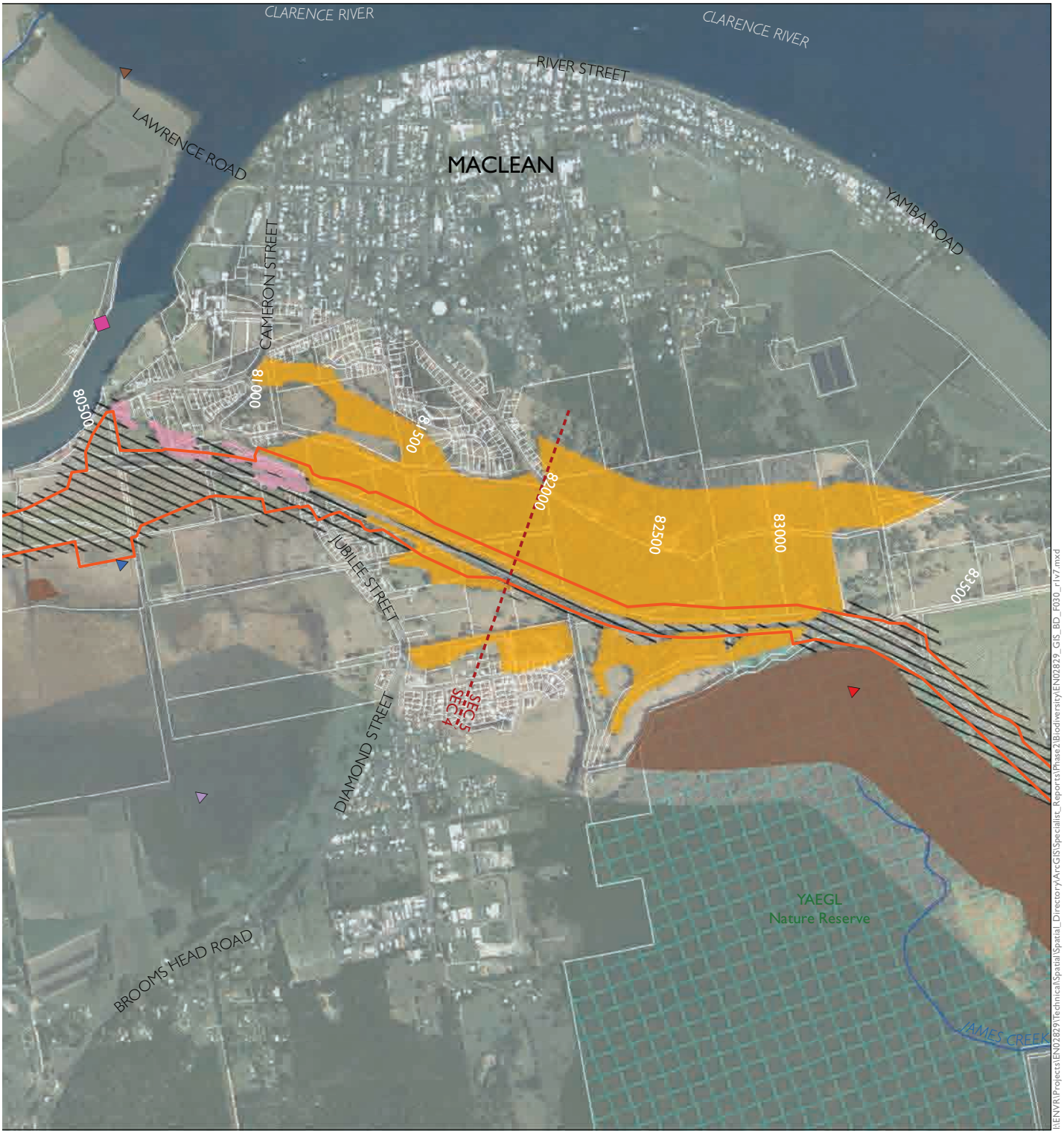

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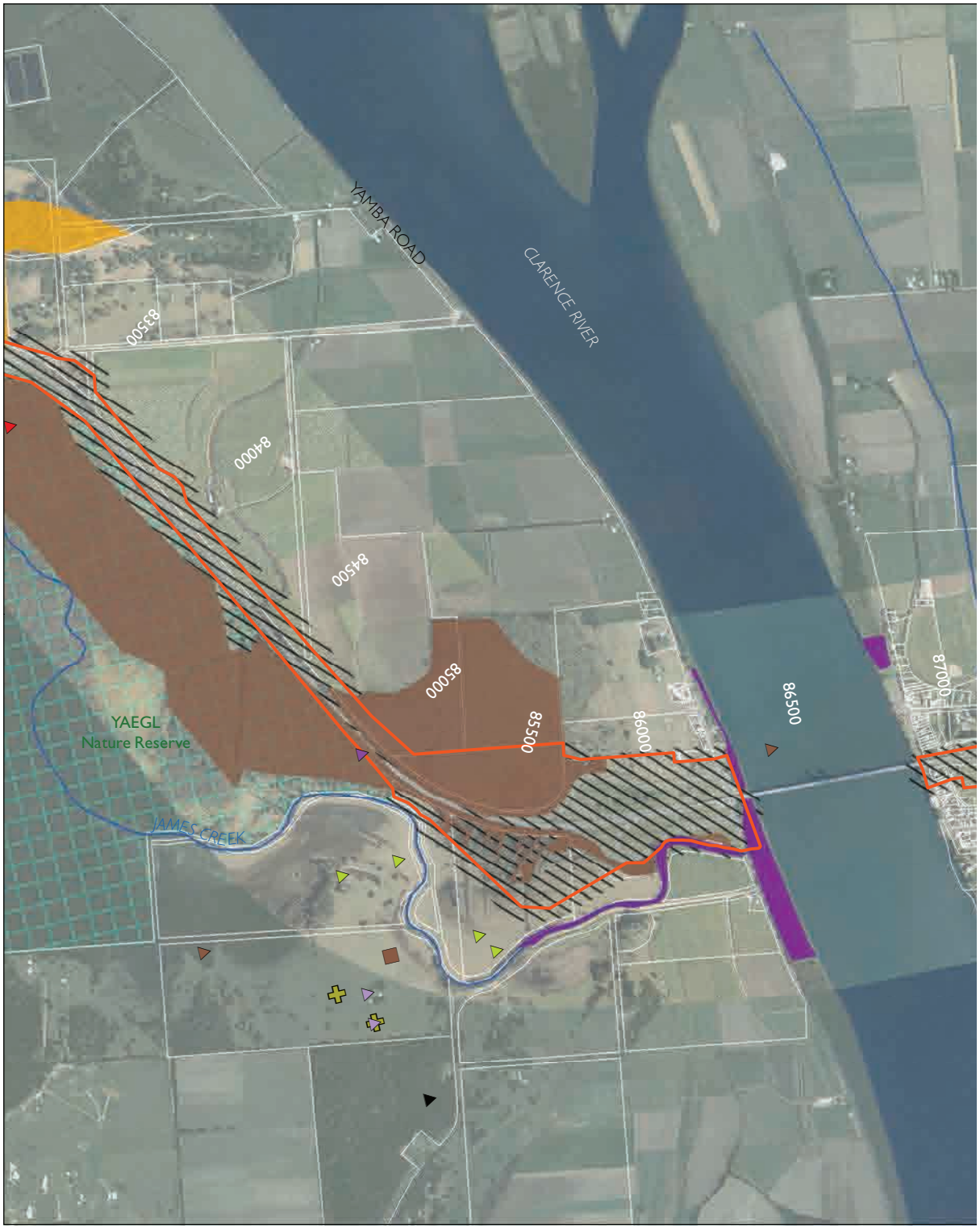
Figure 3 - 47 Fauna habitats and threatened fauna in the study area



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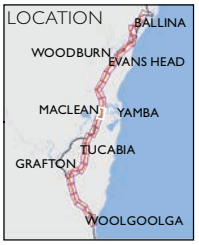
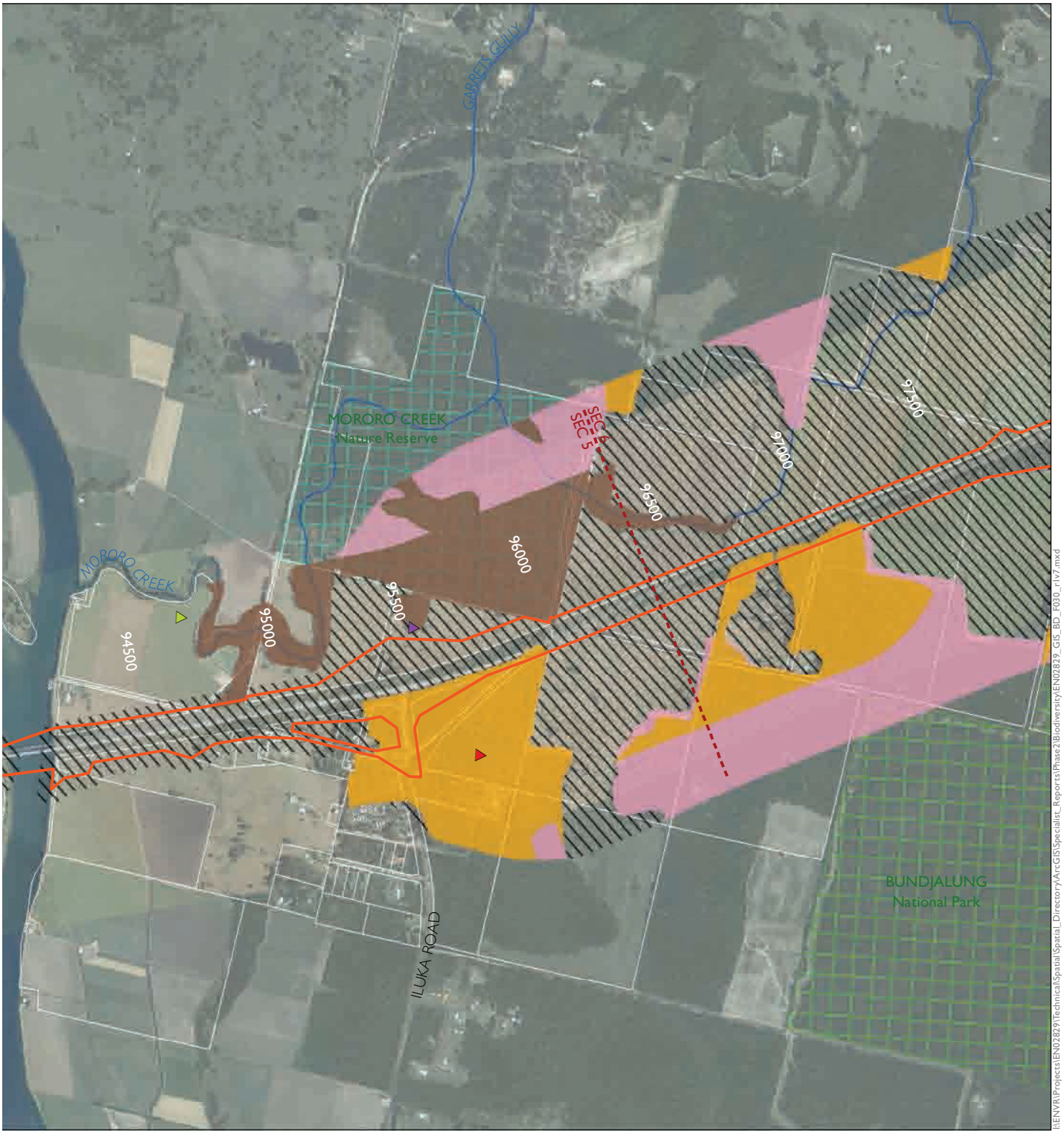


Figure 3 - 48 Fauna habitats and threatened fauna in the study area



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SHEET 15 of 26

Figure 3 - 49 Fauna habitats and threatened fauna in the study area

The project
Upgrade completed to dual carriageway
Upgrade under construction
State Forest
National Park
Nature Reserve / Regional Park / State Conservation Area

*Refer to *Legend sheet B* for fauna map key

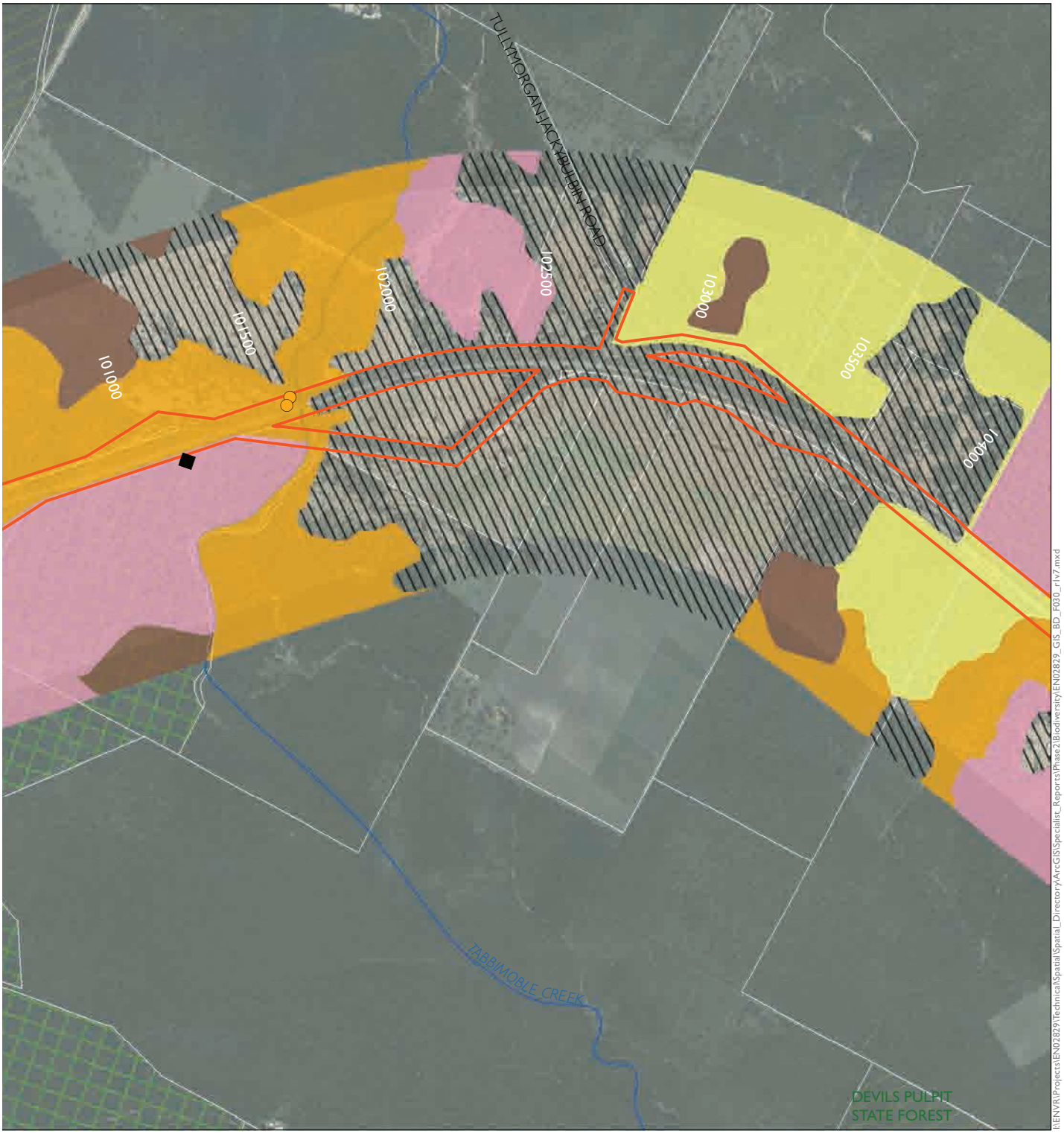

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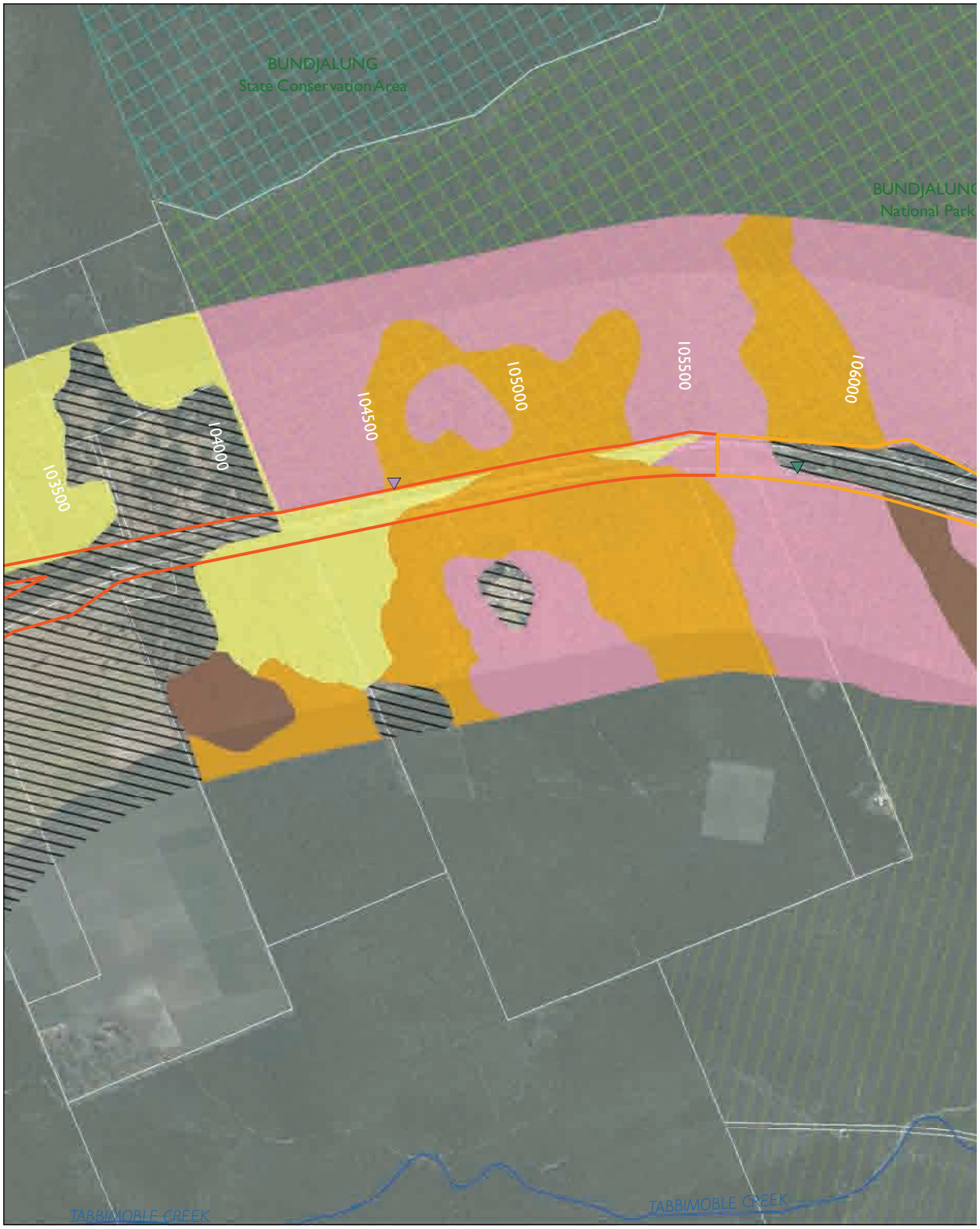
Figure 3 - 50 Fauna habitats and threatened fauna in the study area



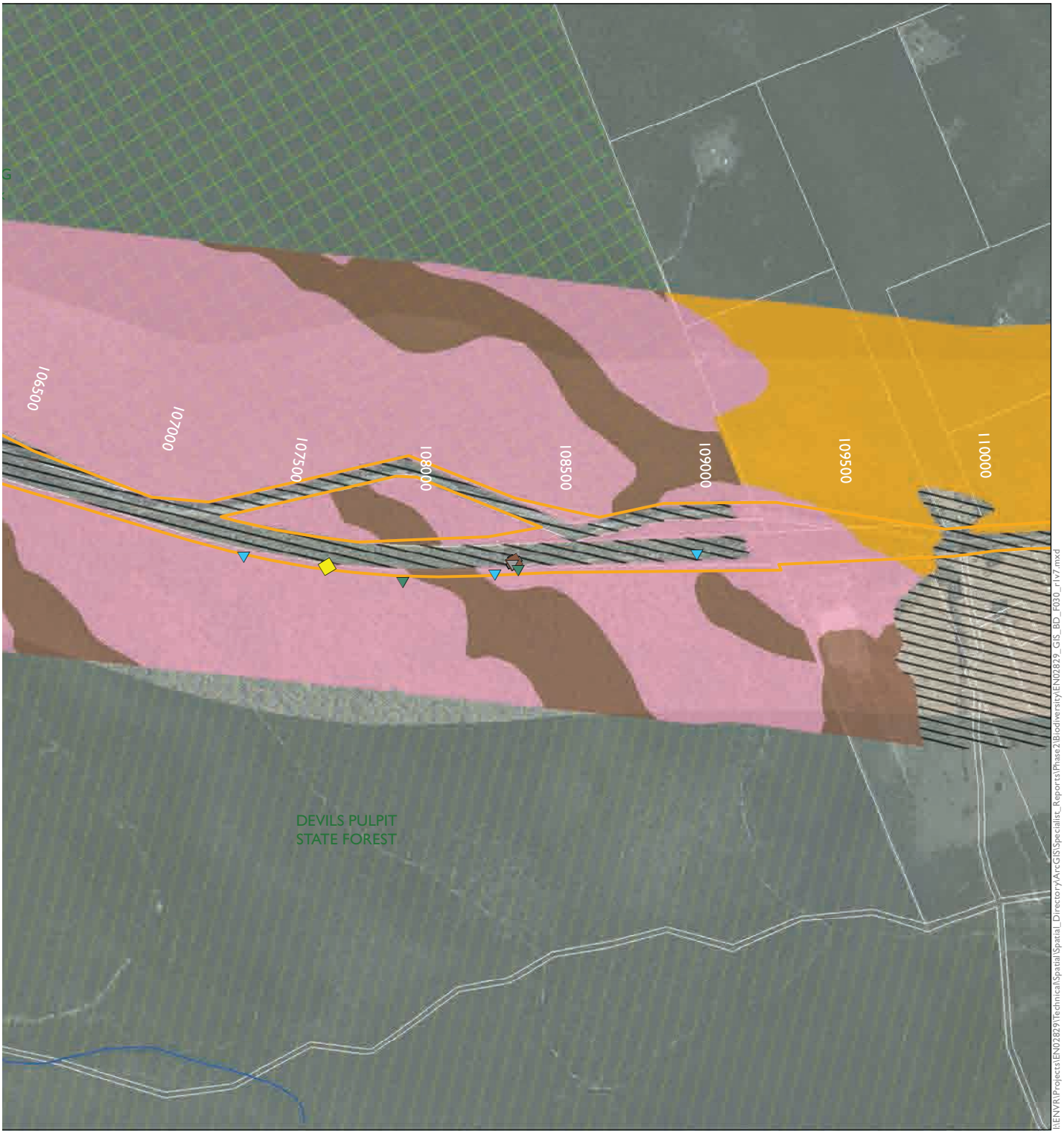


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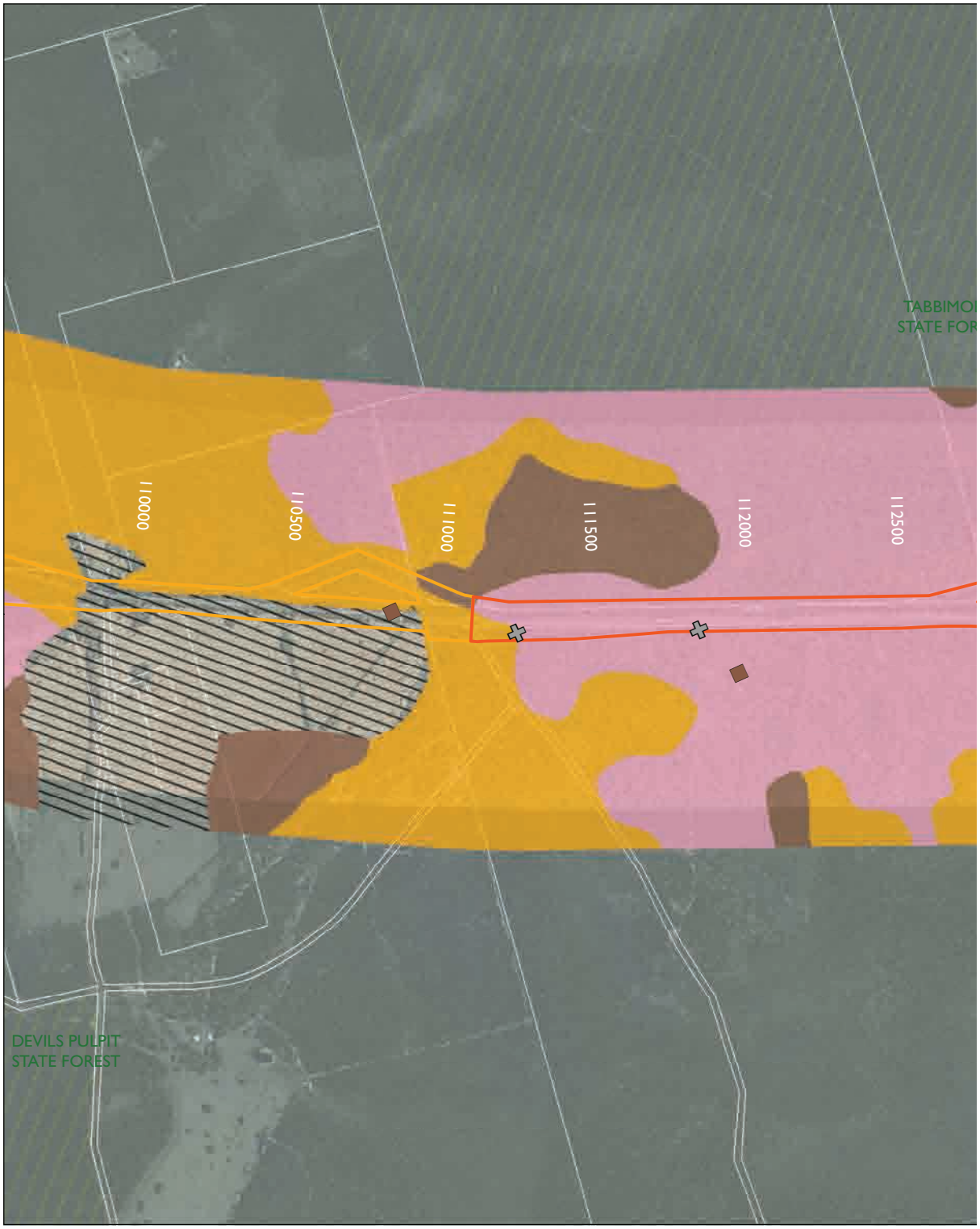
Figure 3 - 51 Fauna habitats and threatened fauna in the study area



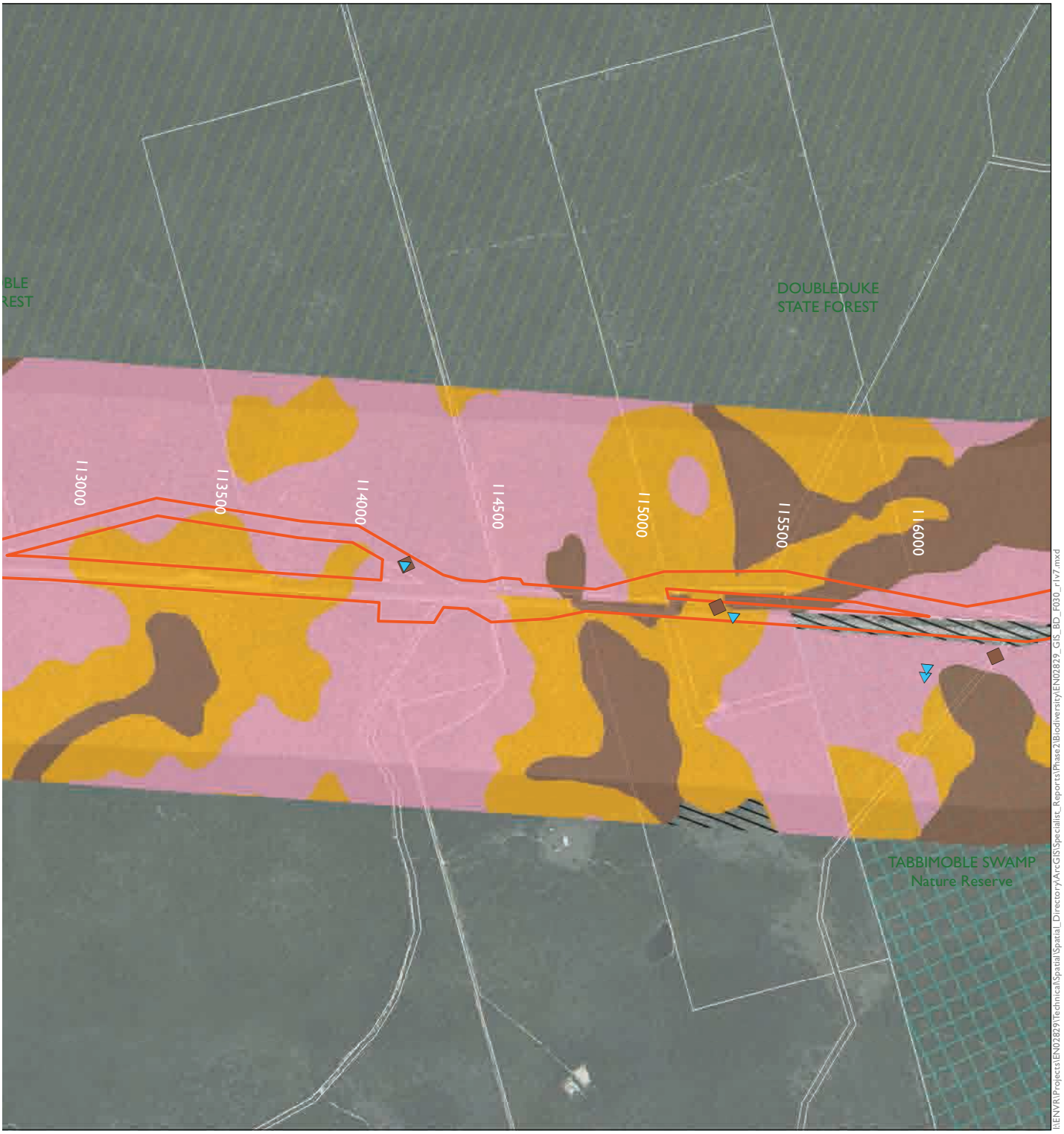


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Figure 3 - 52 Fauna habitats and threatened fauna in the study area

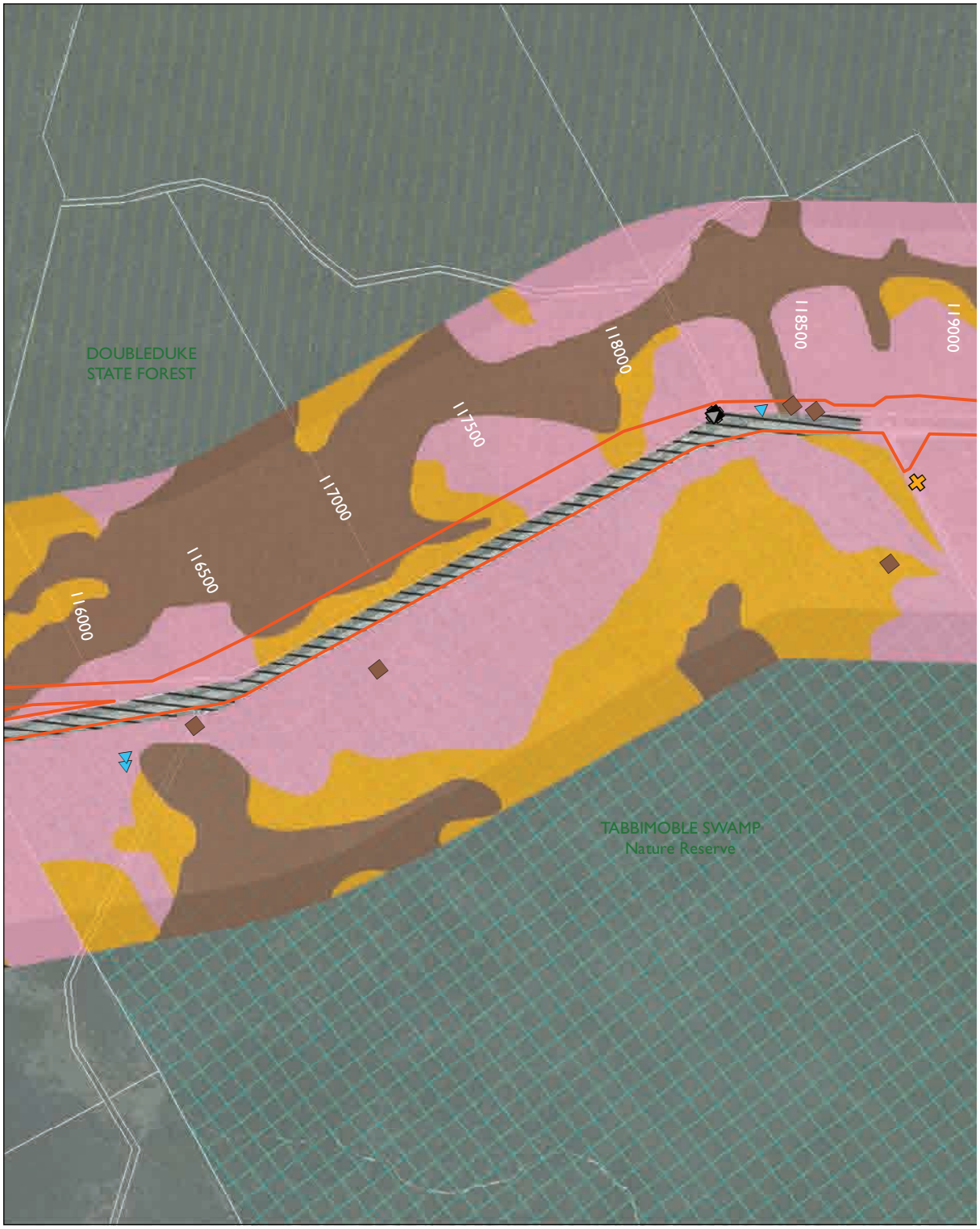

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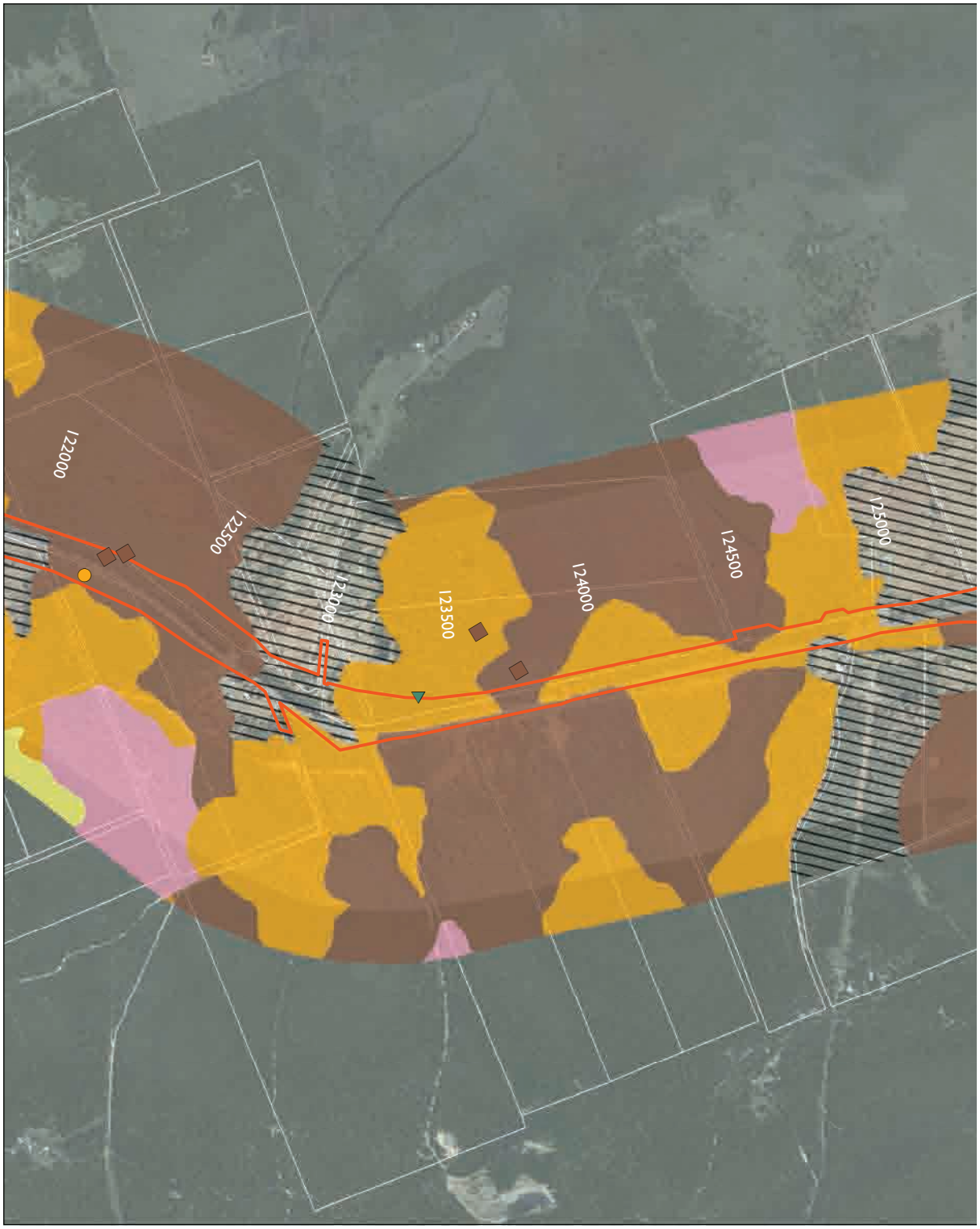
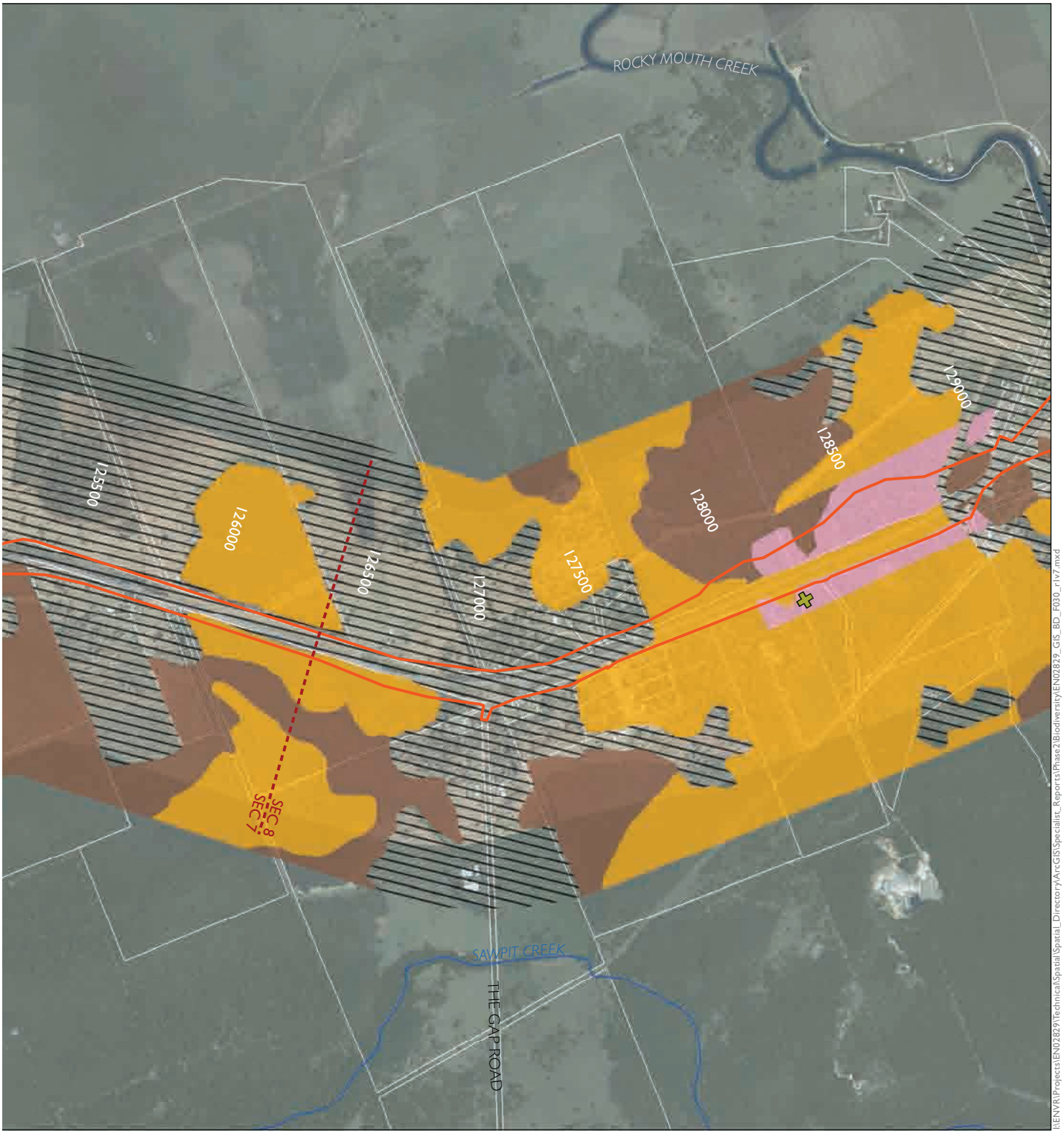
Figure 3 - 53 Fauna habitats and threatened fauna in the study area





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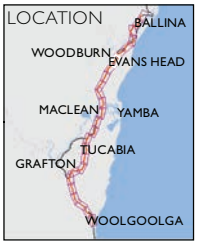
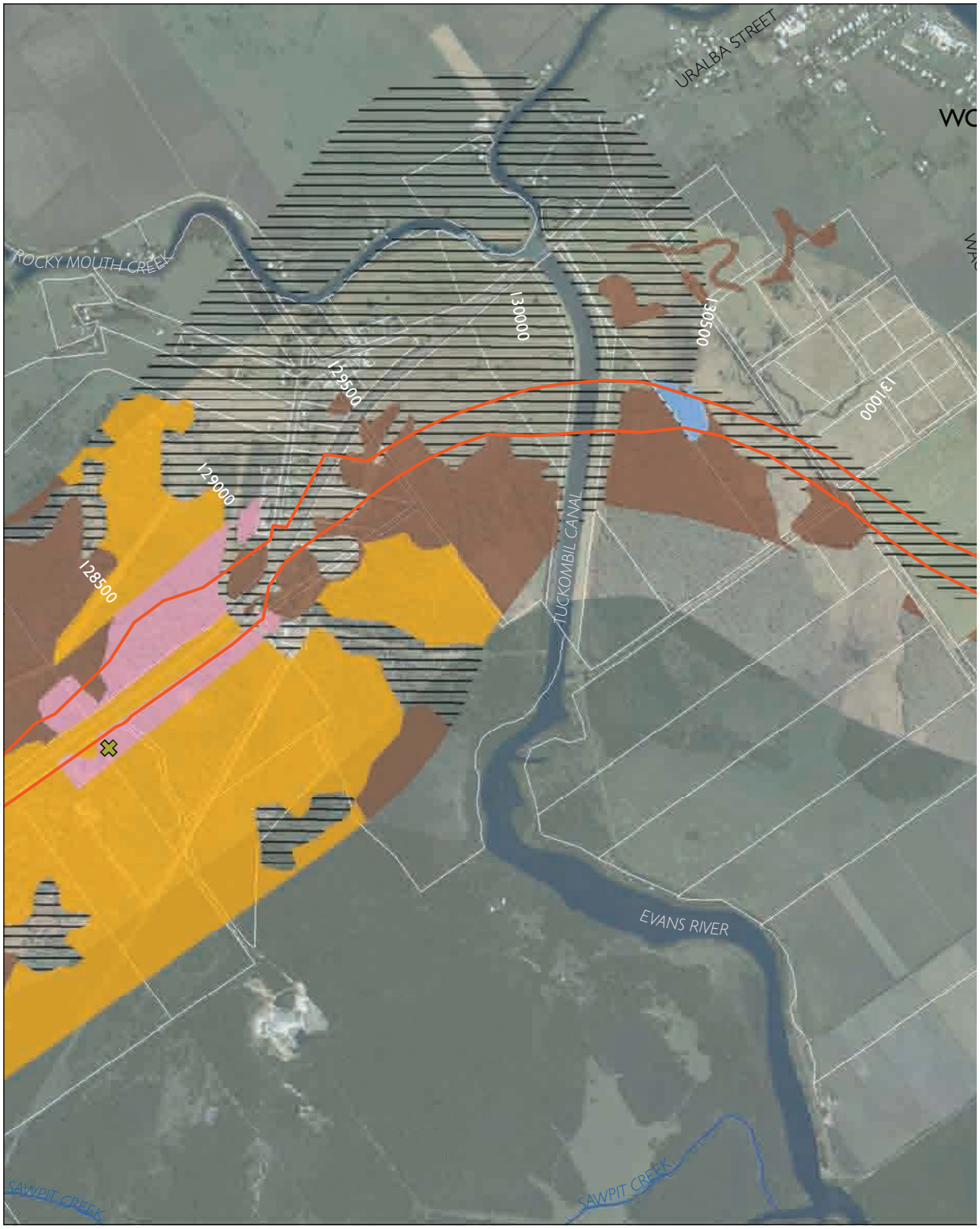


Figure 3 - 54 Fauna habitats and threatened fauna in the study area



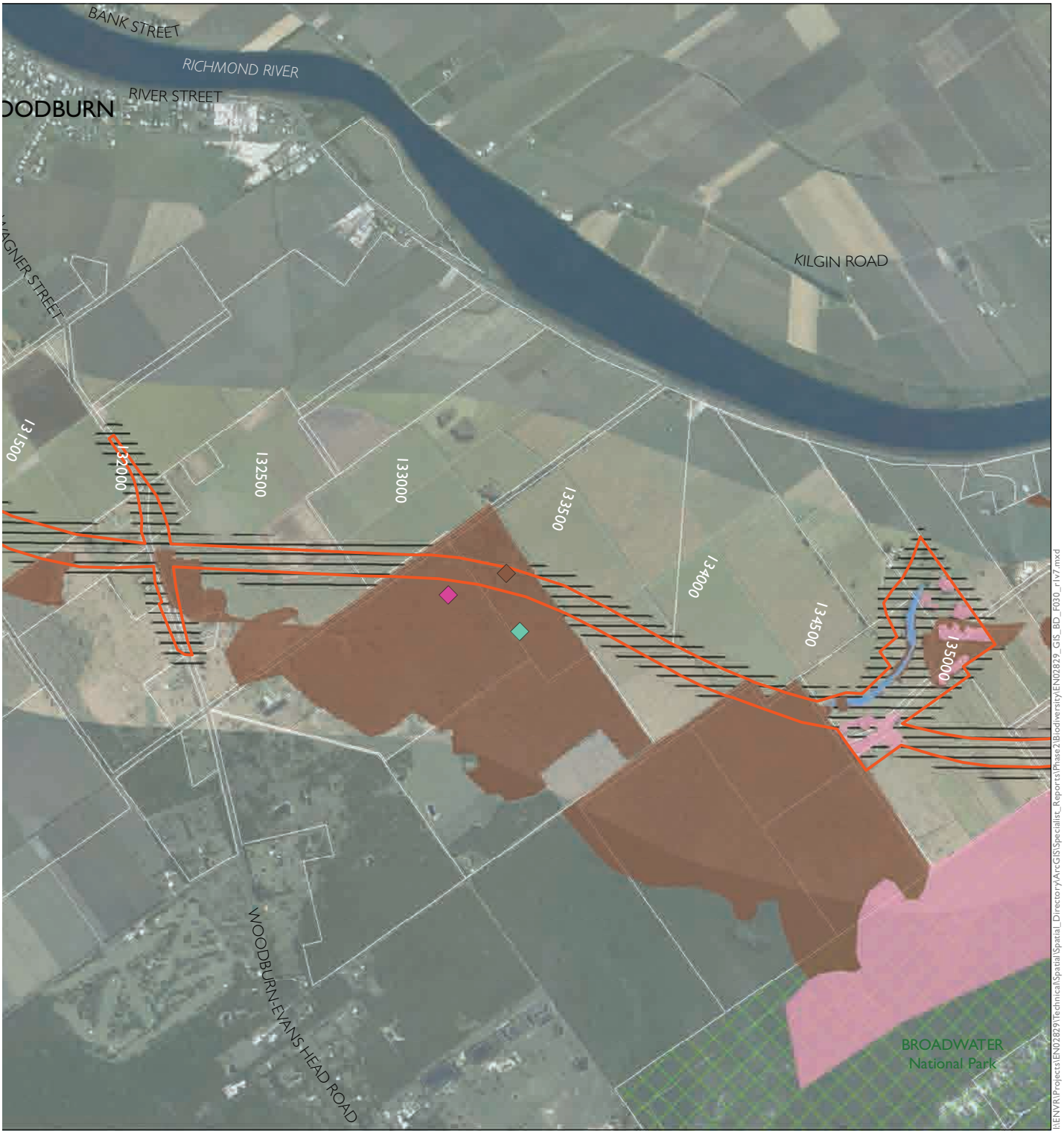


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Figure 3 - 55 Fauna habitats and threatened fauna in the study area

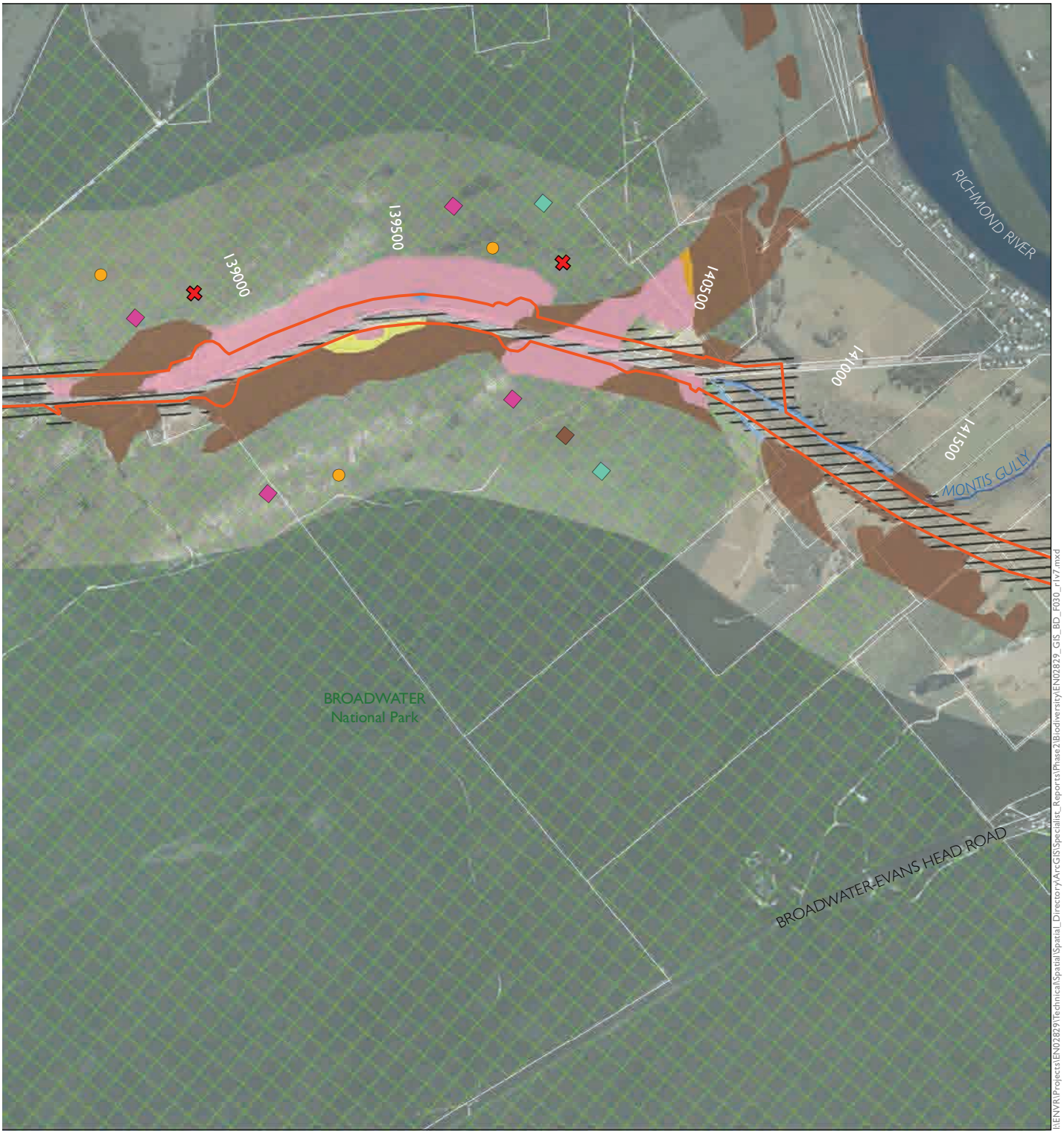

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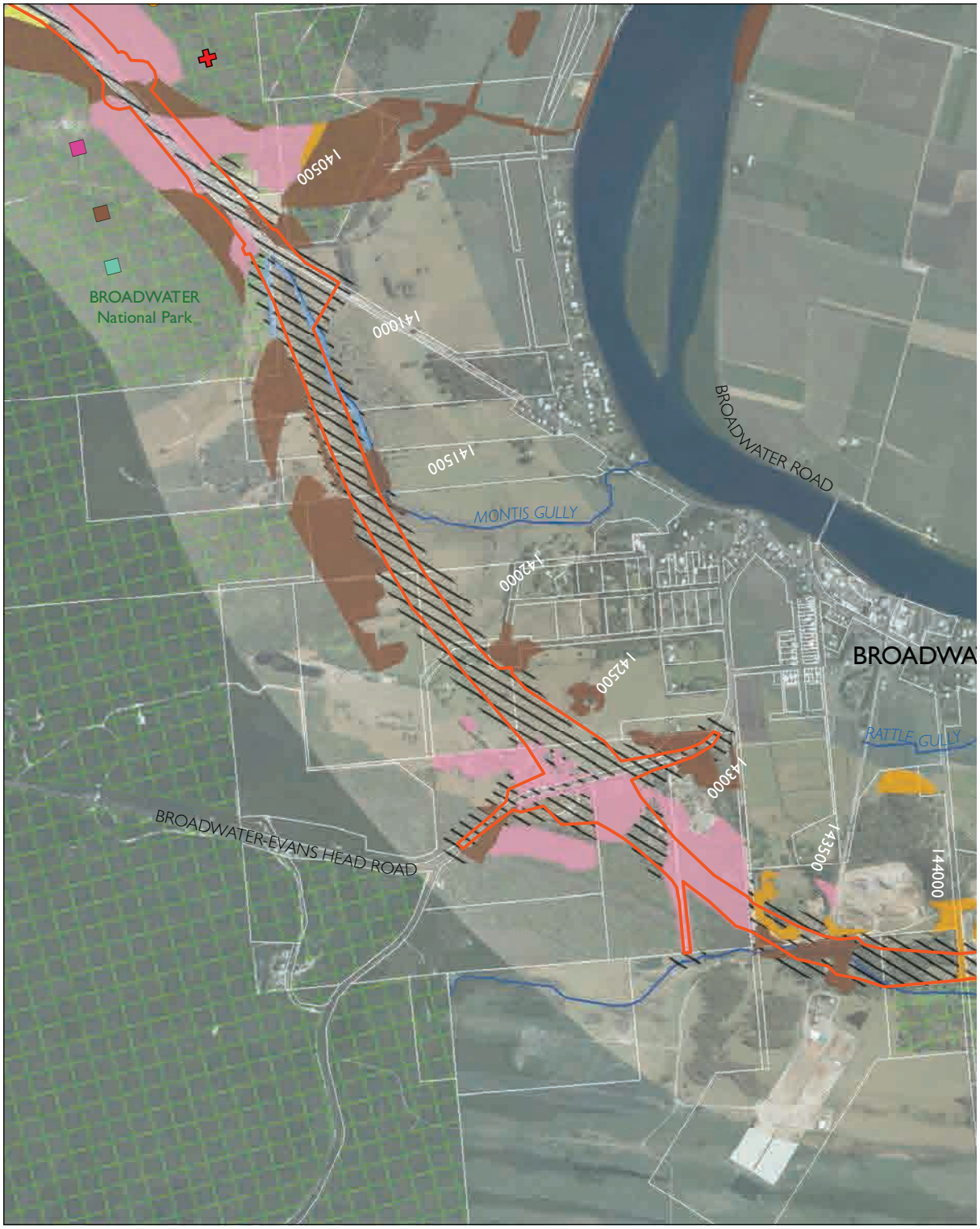
Figure 3 - 56 Fauna habitats and threatened fauna in the study area



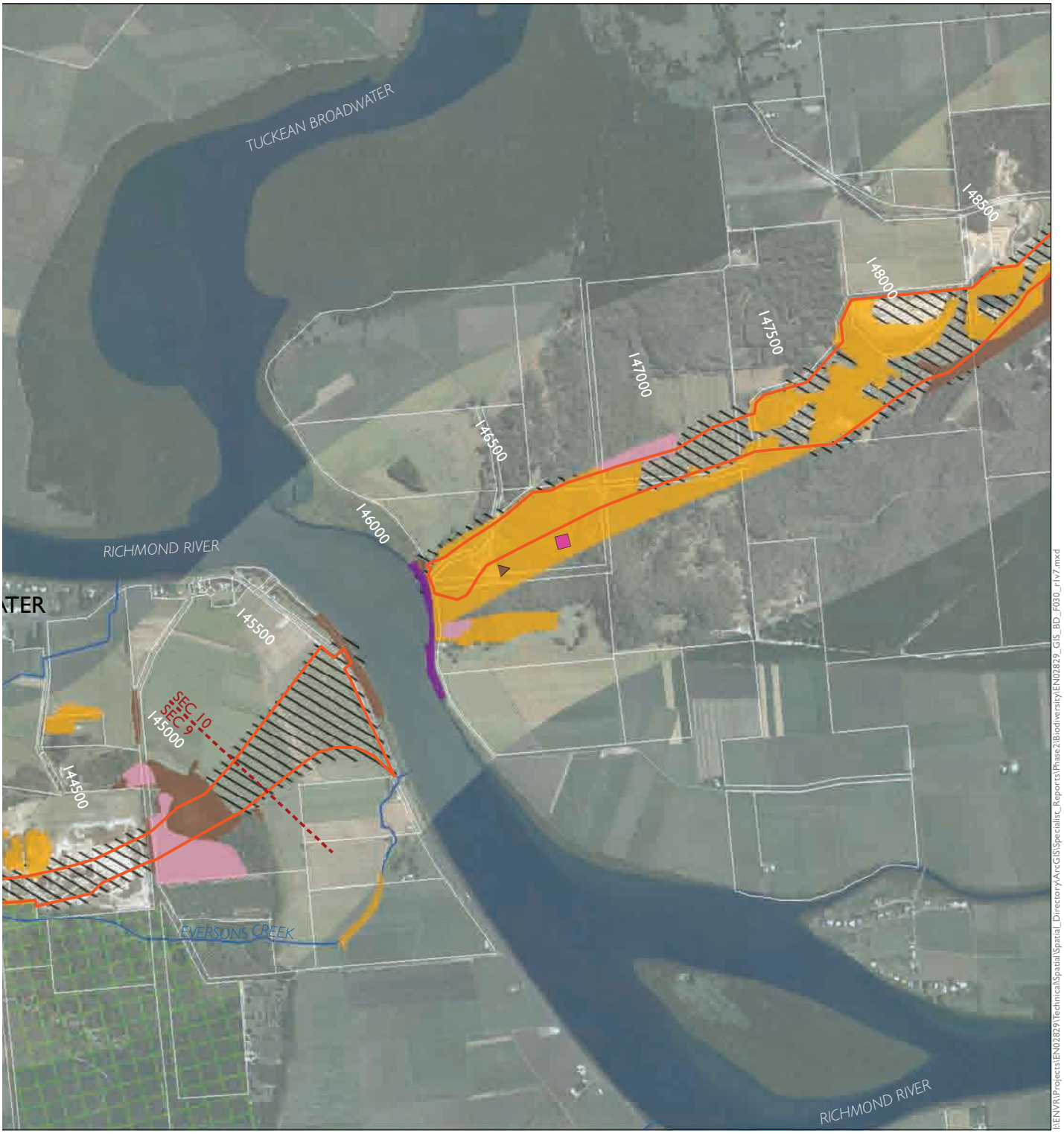


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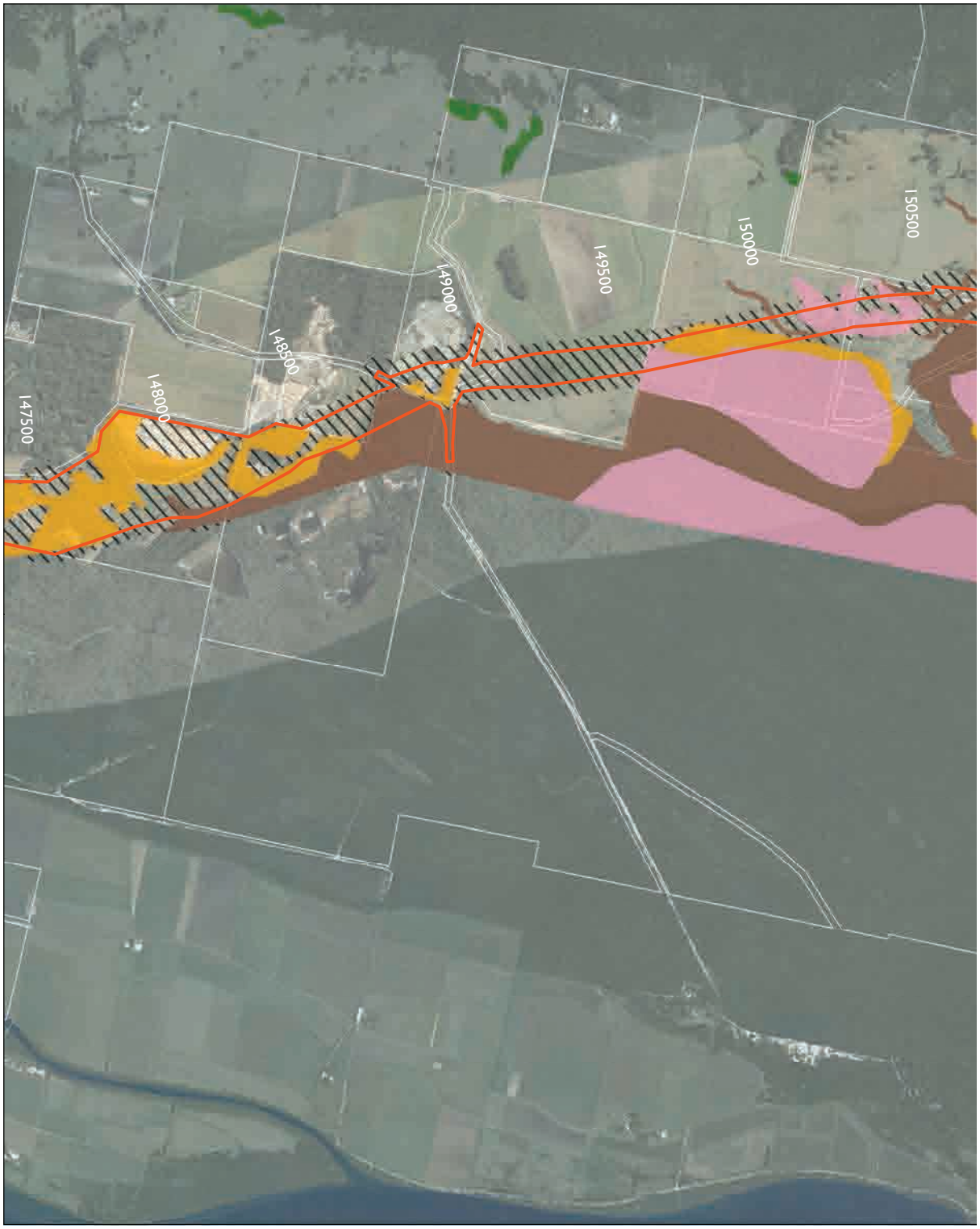
Figure 3 - 57 Fauna habitats and threatened fauna in the study area



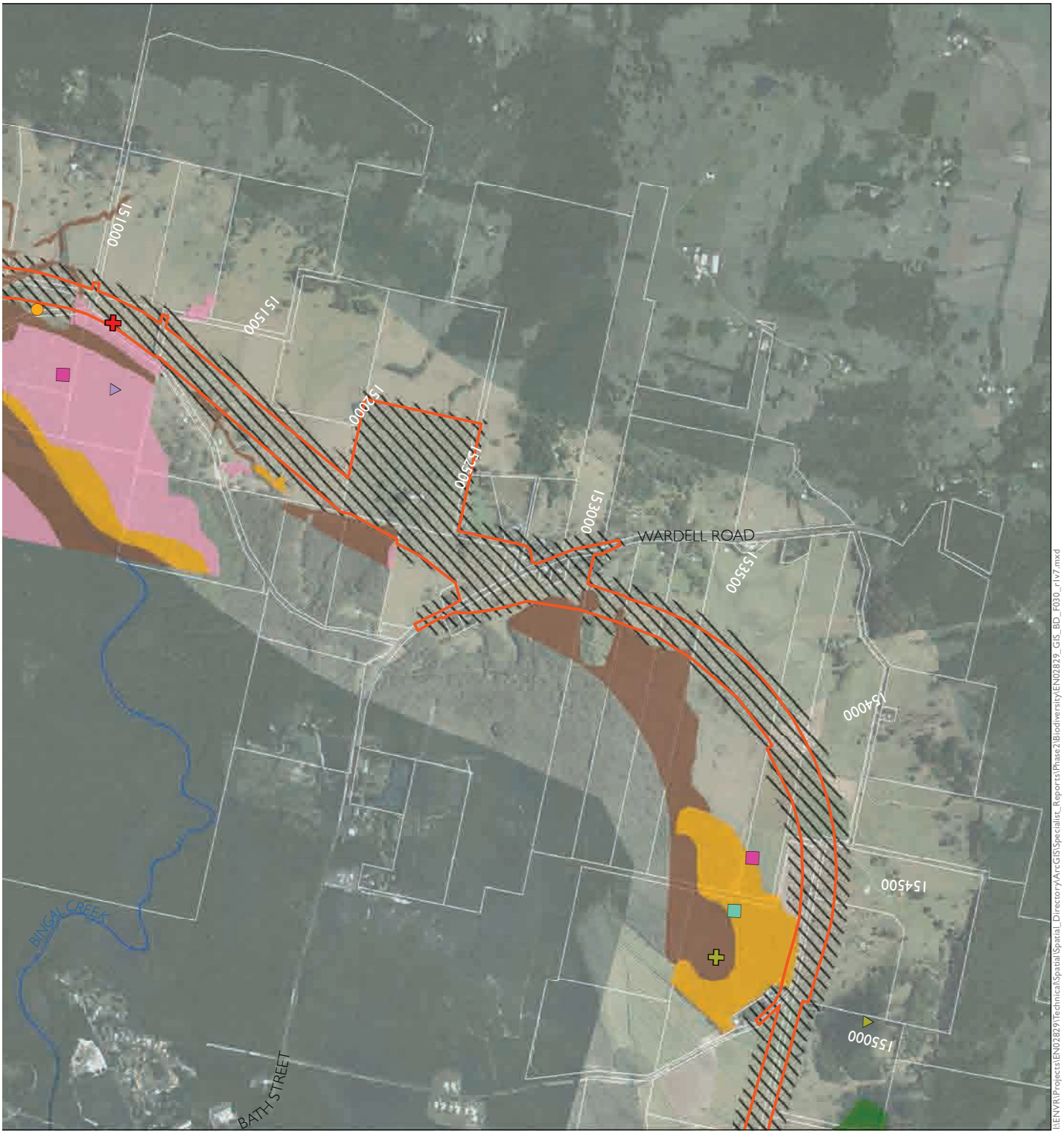


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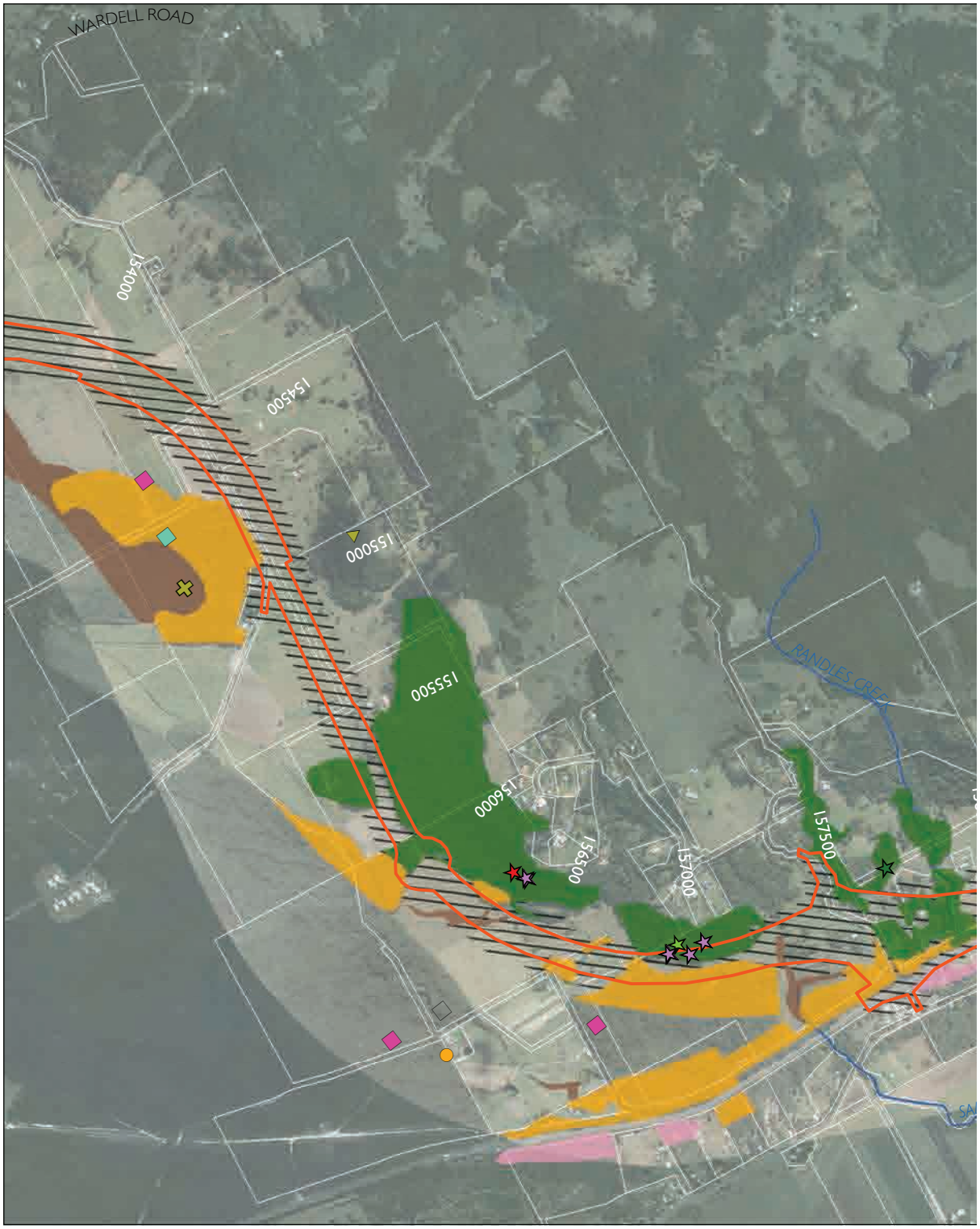
Figure 3 - 58 Fauna habitats and threatened fauna in the study area



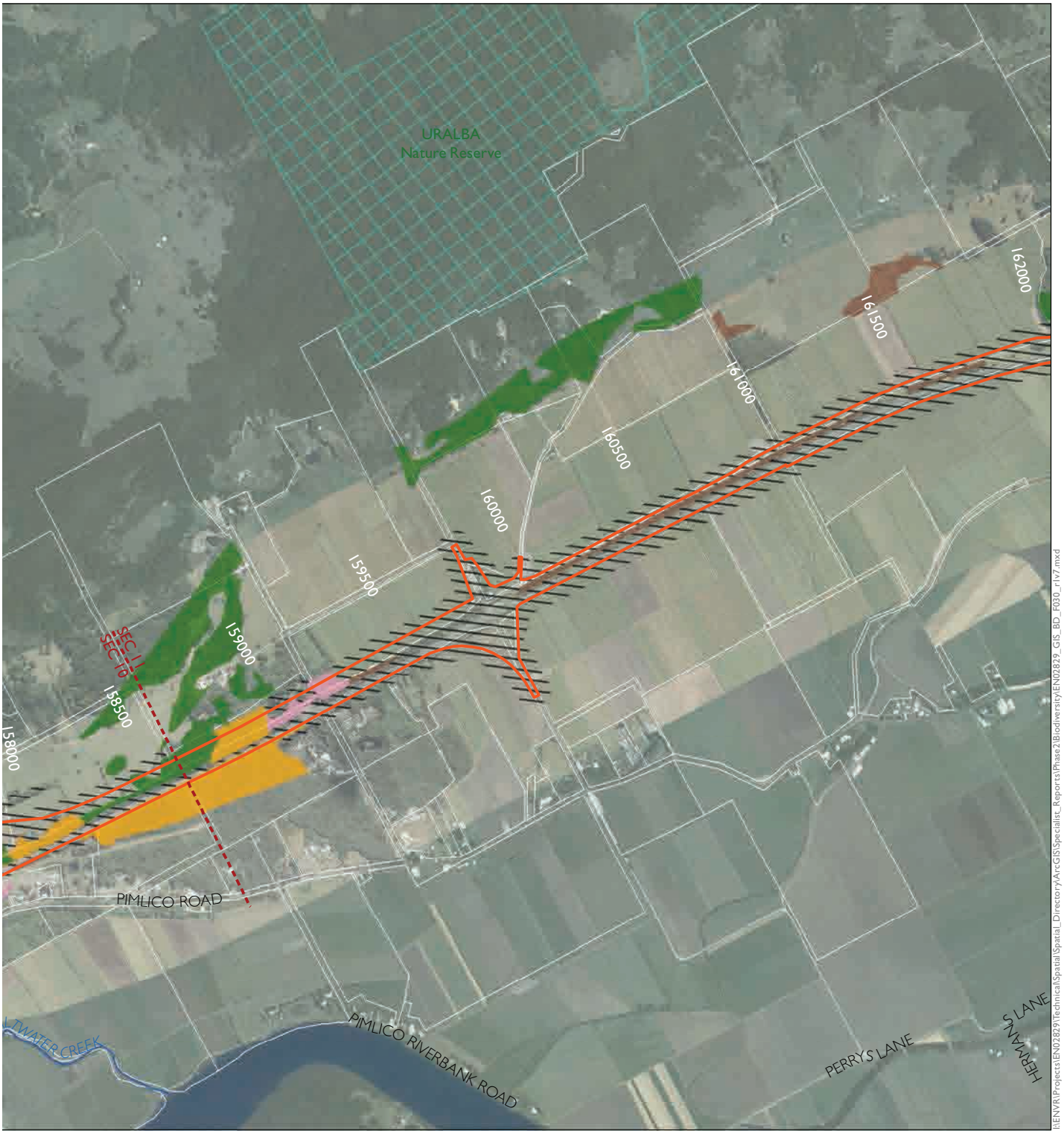


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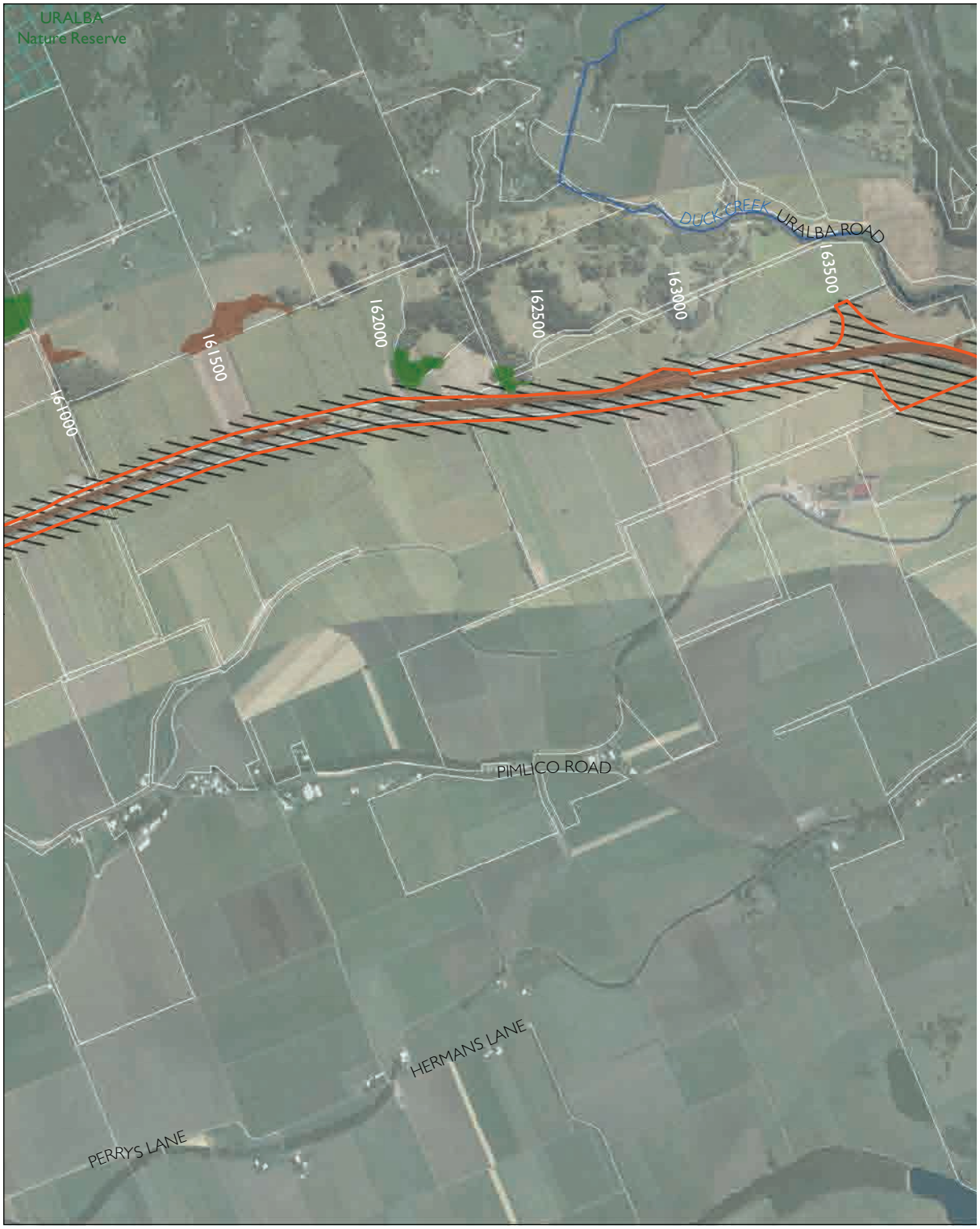
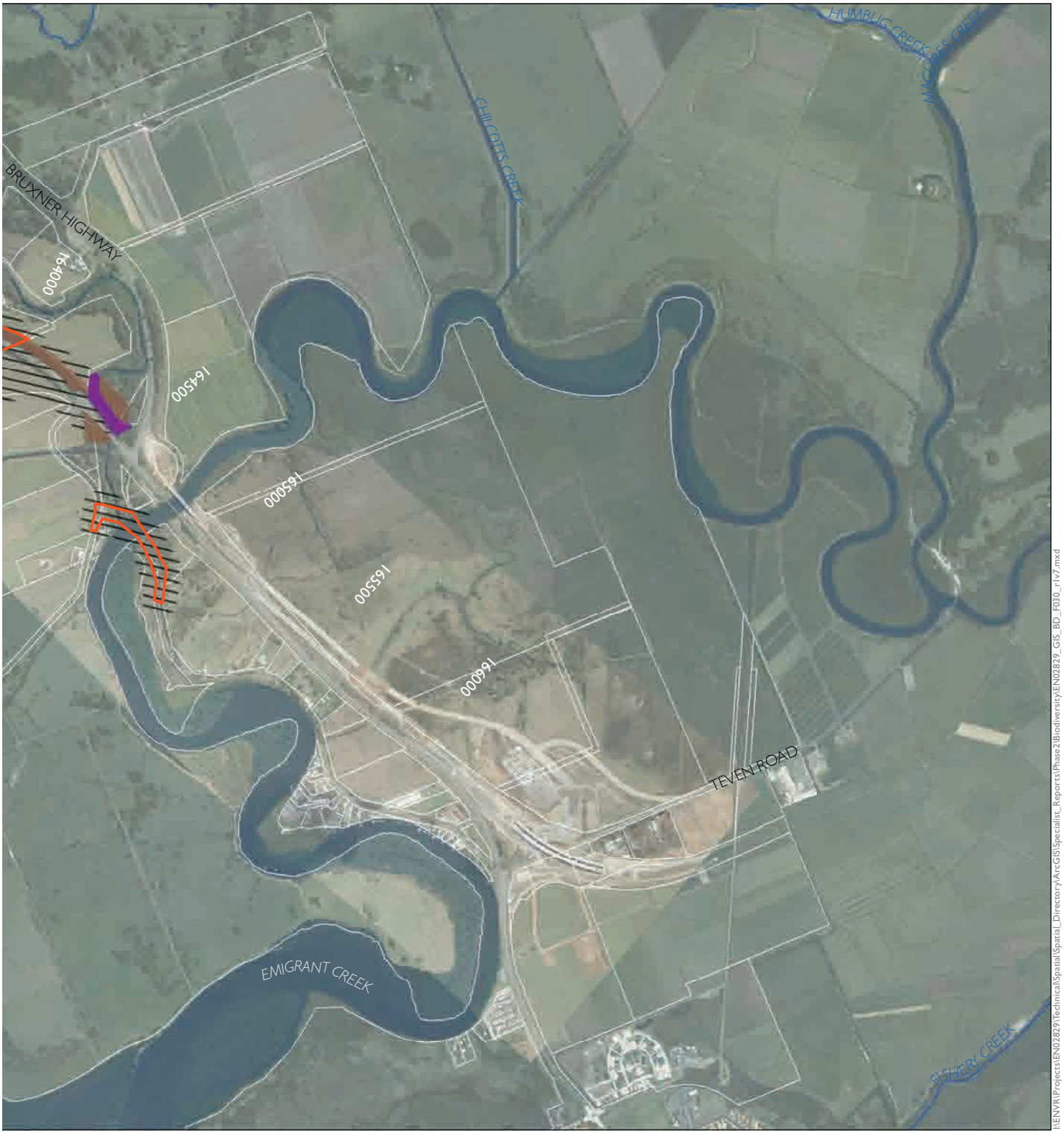
Figure 3 - 59 Fauna habitats and threatened fauna in the study area





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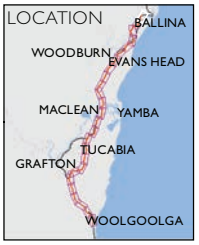


3.6. Fauna species

3.6.1. Vertebrate fauna

A total of 318 fauna species were recorded across the study area, comprising 303 native species (95.3 per cent of all recorded species) and 15 introduced fauna species. The total list of vertebrate fauna recorded from the project surveys is detailed in 0, which identifies 190 bird species, 66 mammal species, 31 frog species and 31 reptile species. Species richness was similar across the project sections despite the differences in the lengths of these sections. This is likely to be a reflection of the diversity of habitat types represented and the fact that each of these habitats is widespread across the study area. The exception is the presence of larger wetlands and moist floodplain habitats in the Clarence River and Richmond River floodplains (sections 4 to 6, 8 to10) which may account for the higher richness of bird species in these sections. Much of the data presented from ecological surveys undertaken 2006 to 2012 identifies fauna presence only with limited abundance data therefore a comparison of species diversity is not presented. Further discussion on abundance and common or rare fauna recorded from the preferred route studies is discussed in RTA (2006-2011)

3.6.2. Invertebrate fauna

Targeted surveys for the threatened Mitchells Rainforest Snail carried out in 2006 (Geolyse 2007) recorded no evidence of the species within or surrounding the project boundary (sections 8 to 11). The ground surveys revealed that the vegetation was not key habitat preferred by the species (Geolyse 2007). The absence of a known co-habitant, the Large Camaenid (*Sphaerospira fraseri*) also led to the conclusion that Mitchells Rainforest Snail was unlikely to occur in the study area (Stanisic 2006).

The supplementary surveys in sections 9 to 11 recorded the presence of the Pink Underwing Moth listed as Endangered under both EPBC Act and TSC Act and Atlas Rainforest Ground Beetle (Endangered TSC Act) within the study area (Figure 3-58 and Figure 3-59).

There was no evidence showing the presence of the other five conservation significant or threatened invertebrate species. The absence of both Richmond Birdwing and Laced Fritillary is thought to be due to the scarcity of host plants rather than the timing of the survey. The likelihood of finding the Coastal Petaltail was reduced because adults are generally short lived after late October. Host plants *Carronia multisepalea* (Host for Pink Underwing Moth) and *Pararistolochia praevenosa* (Host for Richmond Birdwing) were present in section 10 and there distribution is identified on Figure 3-43. The area of Carronia sp. in the study area was recorded as 0.2 hectares; 35 per cent of this occurs in the project boundary. A second stage survey of Carronia sp. habitat recorded findings of the Pink Underwing Moth. High suitability of habitat breeding for Coastal Petaltail occurs in wallum swamp heathland with permanent wetlands of sections 8 and 9.

3.7. Aquatic habitats

The project boundary traverses the lower floodplain catchments of the Clarence River in the south and the Richmond River in to the north, intersecting numerous major and minor tributaries of these systems. Wetlands listed as being of state significance under State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14); of national importance as listed under the Directory of Important Wetlands of Australia, or of international importance (Ramsar) as protected under the EPBC Act, are considered. Table 3-8 provides a summary of aquatic habitats in relation to the project sections.

Table 3-8 Aquatic species and habitats recorded near the project boundary

project section	Summary of aquatic habitats present
1	Crosses a number of lowland freshwater streams including Arrawarra Gully, Corindi River (Class 1), Cassons Creek (Class 1), Redbank Creek (Class 1), Dirty Creek, Dundoo Creek and sections of Halfway Creek (Class 1) all containing aquatic habitats All Class 1 waterways in section 1 are considered potential habitat for the endangered (FM Act & EPBC Act) Oxleyan Pygmy Perch and the endangered (FM Act) Purple Spotted Gudgeon. SEPP 14 wetlands (No. 314) are located about 60 m east of the project near Corindi Beach. There are also SEPP 14 wetlands (No. 315) associated with Arrawarra Gully, however these do not occur in the study area. There are no nationally or internationally listed wetlands in Section 1 as identified by the EPBC Protected Matters Search Tool.
2	The lowland freshwater systems of Halfway Creek (Class 1), Glenugie Creek and Wells Crossing (Class 1) are located within Section 2. Halfway Creek is located about 25 kilometres north of Woolgoolga and wetlands are associated with this creek. Both Halfway Creek and Wells Crossing waterways have potential habitat for Oxleyan Pygmy Perch and Purple Spotted Gudgeon. Glenugie Creek is situated just west of the existing Pacific Highway on the boundary of the Glenugie State Forest. The creek is low flowing, at times depleted of water but provides significant habitat for fish because it has large woody debris and shading from macrophytes. There are no SEPP14 or Ramsar wetlands.
3	There are a number of lowland freshwater rivers and creeks traversed in Section 3. These include Pheasant Creek, Coldstream River (Class 1), Black Snake Creek (Class 1), Pillar Valley Creek (Class 1), Chaffin Creek (Class 1) and Champions Creek (Class 2). Generally these creeks exhibit low flows with often no flows in their upstream reaches after periods of dry weather resulting in low dissolved oxygen and pH and often elevated turbidity. Potential habitat for Oxleyan Pygmy Perch occurs in the waterways of Coldstream River and Pillar Valley Creek and Black Snake Creek. The endangered (FM Act and EPBC Act) Eastern (Freshwater) Cod also has potential habitat occurring in Coldstream River, Pillar Valley Creek and Chaffin Creek. There are small pockets of SEPP 14 wetlands adjacent to sections of Pillar Valley Creek, Champions Creek and Chaffin Creek; however these are not within the project boundary. SEPP 14 wetland No. 237 is located about 0.6 kilometres downstream of the project crossing of Champions Creek. The SEPP 14 wetland (No. 289) which is associated with Chaffin Creek is located about 450 m to the west of the project.
4	Edwards Creek, Shark Creek (Class 1) and South Arm (Clarence River) (Class 1) are located in Section 4. These waterways are tidally influenced estuarine systems, although the upstream reaches of Shark Creek is considered a lowland freshwater ecosystem. The water quality of these streams is generally poor, failing to meet the ANZECC/ARMCANZ (2000) guidelines for protection of aquatic ecosystems. Reasons for poor water quality include low flow, modified channels, exotic weeds and drainage from surrounding sugar cane fields in Edwards Creek, and runoff and bank erosion around Shark Creek and South Arm. SEPP 14 wetland No 232 occurs on the eastern side of the upstream reaches of Shark Creek near the project boundary. There are no Ramsar wetlands listed in the area.

project section	Summary of aquatic habitats present
5	James Creek (Class 1), Clarence River (Class 1), Serpentine Channel (Class 1) and North Arm (Clarence River) (Class 1) are located in Section 5. These are tidally influenced waterways and exhibit estuarine water quality characteristics. Yaegl Nature Reserve is situated on the Lower Clarence floodplain and primarily consists of an estuarine back swamp, however there are sections of James Creek along the eastern boundary of the reserve (east of the highway) that are freshwater (NPWS 2009c). The Clarence River provides potential habitat for Eastern (Freshwater) Cod and the Purple Spotted Gudgeon. Water quality at these sites is generally good, although pH levels in the Clarence River has been reported to fall below the lower limit for the protection of estuarine aquatic ecosystems. The project boundary runs adjacent to SEPP 14 wetland No. 220a. James Creek flows through this wetland which extends into Yaegl Nature Reserve. SEPP 14 wetland No. 153c is located about 0.4 kilometres west of the project boundary crossing of North Arm. There are no Ramsar listed wetlands in Section 5.
6	Section 6 crosses Tabbimoble Creek (Class 1) and is near Nyrang Creek, in addition to several ephemeral drainages. Tabbimoble Creek is estuarine downstream of the weir and freshwater upstream. Water quality in Tabbimoble Creek is generally good and within an ideal range for Oxleyan Pygmy Perch. Records of Oxleyan Pygmy Perch are known to occur in the Tabbimoble Floodways in association with Tabbimoble Creek. Mororo Creek is located about 80 m west of the project but is not directly crossed by it and contains potential habitat for Oxleyan Pygmy Perch. There is a SEPP 14 wetland (No. 153a) located on Tabbimoble Creek about 1 kilometre east of the project boundary. The SEPP 14 wetland (No. 153) is located to the east of the project boundary mostly within the Bundjalung National Park and Devils Pulpit State Forest and extends between the north arm of the Clarence River in the south and the Evans River in the north. There are no Ramsar wetlands in Section 6.
7	There are no major rivers or creeks in this section, but there are several ephemeral streams. These ephemeral streams may not exhibit typical habitat characteristics for Oxleyan Pygmy Perch but they may provide important linkages to key habitats. As a precaution, some of these are likely to represent potential habitat and known records of Oxleyan Pygmy Perch were found in an unnamed creek (Class 1) in Tabbimoble State Forest (chainage 114000). A SEPP 14 wetland (No. 161) is located about 260 m east of the project. There are no Ramsar wetlands located in Section 7.
8	The typically freshwater Tuckombil Canal (upstream of the weir) and MacDonalds Creek are considered Class 1 waterways located in section 8. Oxleyan Pygmy Perch has known records found in MacDonalds Creek, an unnamed watercourse (chainage 134700) and numerous swamps in Broadwater National Park. There are also a number of small ephemeral streams located in this section. The water quality of Tuckombil Canal shows high salinity levels (due to tidal influences downstream of the weir which becomes Evans River) and extremely low dissolved oxygen. Despite estuarine influences of Tuckombil Canal it is considered potential habitat for Oxleyan Pygmy Perch along with Rock Mouth Creek further upstream.
9	Tuckean Broadwater, Montis Gully (Class 2) and Eversons Creek (Class 2) are located in Section 9. Tuckean Broadwater typically exhibits very low pH levels, extremely low dissolved oxygen levels and high turbidity levels, thereby failing to meet some of the water quality requirements for protection of aquatic ecosystems. However, there is good potential habitat (paperbark and wallum heath swamp) in this section for the Oxleyan Pygmy Perch (Ecosense Consulting, 2008) with known records occurring in swamps in Broadwater National Park. SEPP 14 wetland No.119 and mangroves (*Avicennia marina* and *Aegiceras corniculatum)* are located at Tuckean Broadwater (Ecosense Consulting, 2008). The aquatic and riparian habitat at Tuckean Broadwater is considered ecologically significant (Ecosense Consulting, 2008).
10	Richmond River (Class 1) and Randals Creek (Class 2) are located in Section 10. Richmond River generally has average water quality with some sections of the river affected by low pH and/or dissolved oxygen (Hyder, 2008). Aquatic habitats in the Richmond River have potential to support the Eastern (Freshwater) Cod. Tuckean swamps upstream of the Richmond River have good potential habitat for Oxleyan Pygmy Perch

project section	Summary of aquatic habitats present
	SEPP14 wetland no.118 and 118a (northern banks) are located on the northern banks of the Richmond River, either side of the project boundary.
11	Duck Creek (Class 1) and Emigrant Creek (Class 1) are located in Section 11. These are freshwater in their upstream reaches, then estuarine and tidal in the proximity of the proposed alignment. SEPP 14 wetlands No. 108 and No. 95 are located around Duck Creek and Emigrant Creek respectively. There are no Ramsar wetlands listed within Section 11.

3.7.1. Watercourses

Rivers and creek provide a broad range of habitat for a wide diversity of aquatic plant and animal species, as well as supporting a range of ecological processes. Many of the freshwater rivers and creeks in the region are influenced by tidal flows that support freshwater and estuarine flora and fauna. A total of 344 water crossing structures (bridges, culverts and pipes) would be constructed across the project. The large majority of these (68 per cent) would be constructed across shallow ephemeral drainage lines consisting of a class 3 or class 4 waterway. The remaining structures would be built across 20 class 1 waterways (10 per cent) and seventy-four class 2 waterways (22 per cent).

The project design principles state that all Class 1 Waterways should be bridges. All watercourses which provide known habitat for Oxleyan Pygmy Perch have been classified as Class 1 Waterways. For the concept design 19 of the 21 class 1 Watercourse crossing are crossed by bridges. The remaining two class 1 watercourses (Redbank Creek region and the Unnamed Watercourse at STN 134.7 are crossed by culverts). Further design of the structures as per the design principles would be undertaken during detailed design.

A list of all the named waterways within or adjacent to the project boundary and their waterway classification is shown in Table 3-9.

Table 3-9 Watercourses within the project corridor

Project section	Waterway	Waterway classification (Fairfull and Witheridge 2003)	Bridge Crossing Required
1	Arrawarra Creek (crosses existing highway outside of project boundary)	Not Crossed by project	
	Arrawarra Gully	Class 3 or 4	
	Corindi River	Class 1	Yes
	Corindi River Floodplain	Class 3 or 4	
	Blackadder Gully (alongside project boundary)	Not Crossed by project	
	Cassons Creek	Class 1	Yes
	Redbank Creek & associated tributaries	Class 1	No*
	Dirty Creek	Class 3 or 4	

Project section	Waterway	Waterway classification (Fairfull and Witheridge 2003)	Bridge Crossing Required
	Dundoo Creek	Class 3 or 4	
	Halfway Creek	Class 2	
2	Halfway Creek	Class 1	Yes
	Glenugie Creek (alongside project boundary)	Not Crossed by project	
	Wells Crossing	Class 1	Yes
3	Pheasant Creek	Class 3 or 4	
	Unnamed tributary of Glenugie Creek (near STN 39.7)	Class 3 or 4	
	Coldstream River	Class 1	Yes
	Black Snake Creek	Class 1	Yes
	Pillar Valley Creek	Class 1	Yes
	Unnamed tributary of Pillar Valley Creek (near STN 48.0)	Class 3 or 4	
	Chaffin Creek	Class 1	Yes
	Unnamed tributary of Chaffin Creek (near STN 54.6)	Class 3 or 4	
	Champions Creek	Class 2	
4	South Arm (Clarence River - adjacent to project boundary)	Not crossed by project	
	Edwards Creek (near STN 80.2)	Class 3 or 4	
	Shark Creek	Class 1	Yes
5	James Creek (adjacent to project boundary)	Not crossed by project	
	Unnamed tributary of James Creek (near STN 84.4)	Class 3 or 4	
	Clarence River	Class 1	Yes
	Serpentine Channel	Class 1	Yes
	North Arm (Clarence River)	Class 1	Yes
	Mororo Creek (near STN 95.1)	Class 3 or 4	
6	Mororo Creek (near STN 96.7)	Class 3 or 4	
	Tabbimoble Creek	Class 1	Yes
7	Tabbimoble floodway no. 1	Class 2	
	Unknown Creek in Tabbimoble State Forest (STN 114.0)	Class 1	Yes
	Unnamed drainage lines near STN 124.5	Class 2	
	Unnamed drainage lines between STNs 121.7 – 122.2	Class 2	
	Nortons Gully	Class 2	
	Oaky Creek	Class 2	
8	Tuckombil Canal (becomes Evans River)	Class 1	Yes

Project section	Waterway	Waterway classification (Fairfull and Witheridge 2003)	Bridge Crossing Required
	Rocky Mouth Creek (upstream of Tuckombil Canal)	Not crossed by project	
	Unnamed Watercourse (STN 134.7)	Class 1	Yes*
	Unnamed tributary of Macdonalds Creek STN 136.5	Class 2	
	Macdonalds Creek	Class 1	Yes
9	Montis Gully	Class 2	
	Unnamed tributary of Montis Gully	Class 2	
	Eversons Creek	Class 2	
10	Tuckean Swamp (upstream of Richmond River)	Class 3 or 4	
	Tuckean Broadwater (upstream of Richmond River)	Class 3 or 4	
	Richmond River	Class 1	Yes
	Unnamed tributaries of Bingal Creek (at STNs 149.2, 150.6 and 153.9)	Class 3 or 4	
	Saltwater Creek	Class 3 or 4	
	Randals Creek	Class 2	
11	Duck Creek	Class 1	Yes
	Emigrant Creek	Class 1	Yes

** To be addressed in the detailed design*

3.7.2. Important wetlands

The location, condition and significance of wetlands are described by Section in Figure 3-60 to Figure 3-70 and shown in Table 3-10. A total of 22 SEPP 14 wetlands have been identified within the study area and eight nationally important wetlands including the Clarence River Estuary, Bundjalung National Park and Coldstream Wetlands (Directory of Important Wetlands of Australia). There are no Ramsar wetlands present in the study area. A list of nationally important wetlands is detailed in Table 3-10 and SEPP (State Environmental Planning Policy No14) wetlands in Table 3-11.

The project traverses a portion of the Clarence River Estuary, crossing the Clarence River at Harwood. The Clarence River Estuary covers a total of 1700 hectares and is comprised of a range of aquatic habitats that support a diverse fish and crustacean fauna. The estuary is considered to be in fair condition (DSEWPaC 2010b), but is under pressure from changed hydrology in the catchment arising from historic flood mitigation works, dredging, and sedimentation, and filling and draining of adjacent wetlands (Smith 2011). It is also affected by exotic weeds (Water Hyacinth *Eichhornia crassipes* and Bitou Bush *Chrysanthemoides monilifera*), grazing, chemical runoff from agricultural activities and acid sulfate soils (DSEWPaC 2010b).

Wetlands associated with the Bundjalung National Park occur near the project boundary and would be traversed at the North Arm. The wetlands here occupy an area of 17,738 hectares and are in relatively good condition, but under pressure from altered hydrology, exotic weeds and feral animals (DSEWPaC 2010b).

The Upper Coldstream Wetland is a nationally important wetland. It occurs in Section 3, around 600 metres east of the project, and occupies 1955 hectares (Environment Australia 2001). It is considered in fair condition, but is under pressure from changed hydrological conditions, exotic weeds and grazing (DSEWPaC 2010b). The wetland has also been affected by land-use changes and is fragmented, particularly due to the high density of roads in the region. Due to changed drainage patterns and the dominance of pasture species, flooding can cause major 'blackwater events' (DECC 2008). Around eight kilometres squared of the Upper Coldstream Wetland has been classified as SEPP14. Both the Coldstream River and Pillar Valley Creek flow through the Upper Coldstream wetland and the project crosses both these systems.

The wetland cluster on Tabbimoble Creek (Section 6) is ecologically significant because it is relatively intact and known to support threatened flora, fauna and ecological communities (DECC 2008a). It has been identified as key habitat (DEC 2003), particularly for mammal species, and forms part of a regional corridor. Five threatened plant species known to occur in the wetlands.

Table 3-10 Nationally Important wetlands in the region

Wetlands	Type	Land use	Area (hectares)
The Broadwater	Offstream tidal waterbody of the Clarence Estuary	Forestry, agriculture. It is located more than 4.3 km west of the project boundary and more than 10 km upstream of the project crossing with the Clarence River.	2 800
Bundjalung National Park	Coastal dunal wetland	National Park. North Arm, Back Channel and Middle Channel are the main waterways associated with this wetland and the project boundary, with North Arm crossed by the project at Chatsworth.	17 738
Clarence River Estuary	Estuary and SEPP 14	Fishery and agriculture. This wetland which includes the Clarence River itself, is directly crossed by the project at Harwood	1 700
Cowans Pond Reserve	Open water body	Conservation, particularly for water birds. Located more than 16 km (straight line distance) from the project.	5
Everlasting Swamp	Freshwater meadow and seasonal swamp	Agriculture and forestry. It is located more than 7 km west of the project boundary.	1 930
Lake Hiawatha and Minnie Water	Freshwater lakes	Conservation, agriculture and fishing. This wetland is located more than 14.5 km (straight-line) distance to the east of the project	367

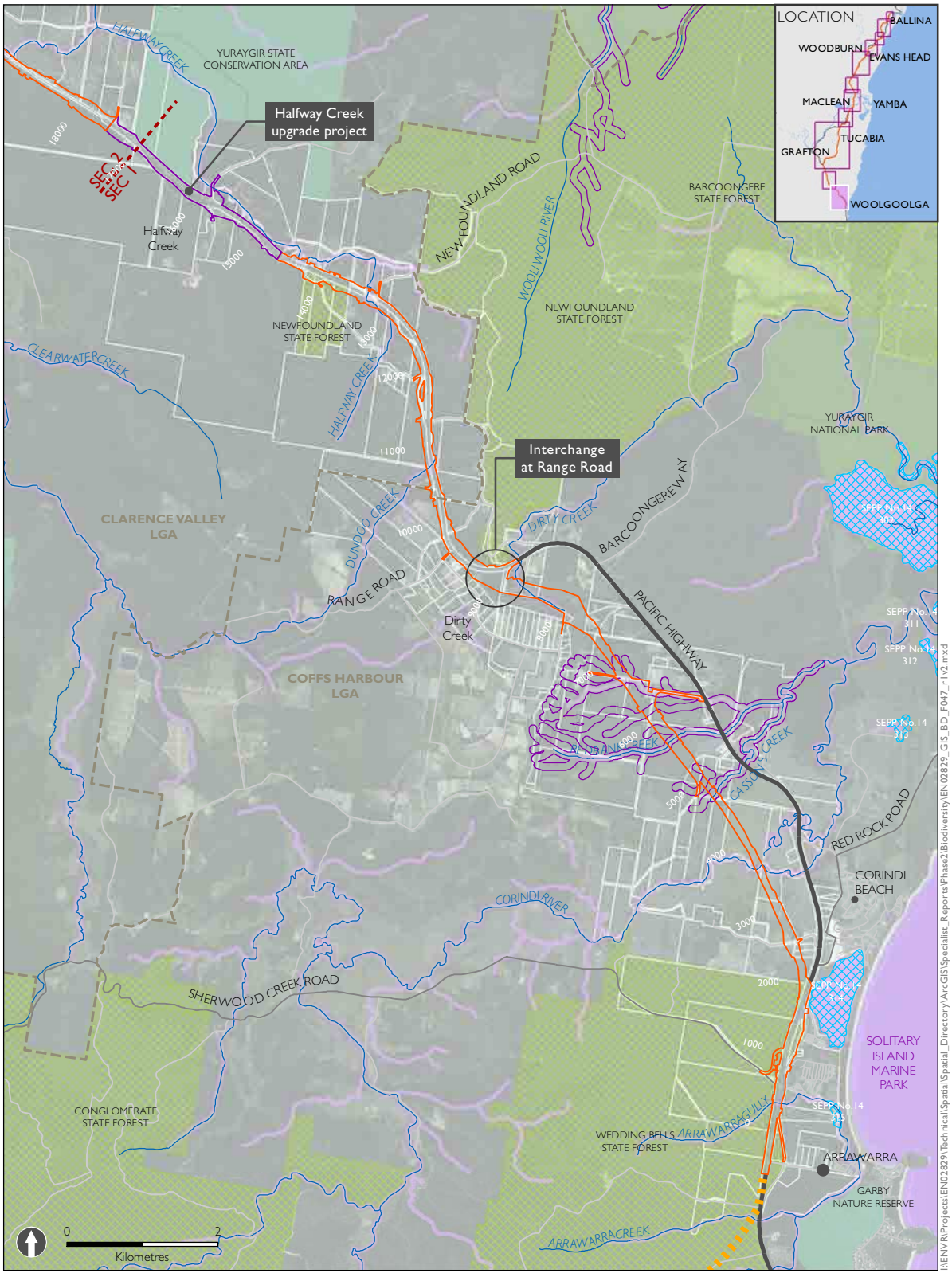
Wetlands	Type	Land use	Area (hectares)
		corridor.	
Upper Coldstream	Coastal floodplain swamps	Agriculture and forestry. Located at to the north and west of the project boundary, generally >60m straight-line distance. The Coldstream River and Pillar Valley Creek flow through this wetland, downstream of the project boundary and creeks crossing.	1 995
Wooloweyah Lagoon	Tidal lagoon	Fishery, conservation and agriculture. The Lagoon is located more than 7 km (straight-line distance) from the project boundary. Palmers Channel, a tributary of the Clarence River flows into the Lagoon, around 10 km downstream The confluence of Palmers Channel and the Clarence River is 2.2km downstream of the project crossing of the Clarence River itself.	2 390

Table 3-11 SEPP14 wetlands in the region

Project section	Wetland Identification	Details
Section 1	No.314	Located about 102.5 metres (straight-line distance)-east of the project boundary near Corindi Beach. There is no watercourse that flows directly into this wetland
	No.315	Located around 760 metres downstream of the project crossing of Arrawarra Gully (and 647.8 m straight line distance).
Section 3	No. 283~~7~~	Located around 385 m (straight-line distance) to the west of the project boundary at its closest point. Champions Creek flows through this wetland around 700 metres upstream of the project boundary crossing with Champions Creek
	No. 289	Located to the west of the project boundary, around 300 metres (straight-line distance) at its closest point. Chaffin Creek flows through this wetland around 1.9 kilometres downstream of the project boundary crossing of the creek itself.
	No. 292	Located to the west of the project boundary, around 750 metres (straight-line distance) at its closest point. Both the Coldstream River and Pillar Valley Creek flow into this wetland, around 2.5 kilometres and 3.3 kilometres downstream of the project crossing.
Section 4	No.232	Located around 720 metres (straight-line distance) to the east of the project boundary and 70 metres (straight-line distance) east of Shark Creek. Shark Creek flows through this wetland around 7.6 kilometres downstream of its crossing with the project boundary.
Section 5	No. 220a	Located to the south east of the boundary, around 35 metres at its closest point (straight-line distance) and south of Harwood Bridge. James Creek, a tributary of the Clarence River flows into this wetland (and a portion of Yaegl Nature Reserve) around 2.7 kilometres downstream of the project boundary. James Creek terminates in this SEPP14 Wetland.

Project section	Wetland Identification	Details
	No.153c	Located around 465 metres west of the project boundary crossing of North Arm of the Clarence River. The wetland is between Back Channel a tributary of North Arm and North Arm itself, each crossing the SEPP14 boundary around 515 metres upstream of the project crossing of North Arm.
Section 6	No.153a	Located on Tabbimoble Creek about 1.4 kilometres downstream of the project crossing of Tabbimoble Creek itself and around 890 metres east (straight-line distance) of the project corridor.
	No.153	Located greater than 1.5 kilometres (straight-line distance) to the east of the project boundary mostly within the Bundjalung National Park and Devils Pulpit State Forest. It extends between the North Arm of the Clarence River in the south and the Evans River in the north. The Esk River is the main waterway associated with the wetland, however this project does not directly cross the river.
Section 7	No.161	Located about 320 metres east of the project. There is no waterway directly associated with this wetland.
Section 8	No. 133	Located around 670 metres to the east of the project. The Evans River flows through the northern boundary of the wetland, around 465 metres downstream of the weir (separating Tuckombil Canal and the Evans River). Tuckombil Canal is traversed by the project around 820 metres upstream of the weir.
	No. 134	Located around one kilometre to the east of the project. The Evans River flows through wetland, around 330 metres downstream of weir (separating Tuckombil Canal and the Evans River). Tuckombil Canal is traversed by the project around 820 metres upstream of the weir.
Section 9	No.119	Located at Tuckean Broadwater, and dominated by mangroves (namely the species *Avicennia marina* and *Aegiceras corniculatum)*. The aquatic and riparian habitat of the Tuckean Broadwater is considered to be ecologically significant. The wetland is located 770 metres (straight-line) and 1.3 kilometres upstream of the project crossing of the Richmond River.
Section 10	No.118 and 118a	Located on the northern banks of the Richmond River, either side of the project. SEPP14 wetland no 118 is around 125 metres upstream (and straight-line distance) of the project crossing of the Richmond River. SEPP14 no. 118a is 420 metres downstream (and straight-line) of this crossing.
Section 11	No.108 and 95	Located on Duck Creek and Emigrant Creek respectively. SEPP14 No. 108 is located on the eastern bank of Emigrant Creek is crossed by the project at its southern boundary. SEPP 14 No. 95 is directly intersected by the Project. .
	No. 108a, 96, 97 and 98	These SEPP14 wetlands are all located downstream of the project crossing along Emigrant Creek. SEPP14 No. 108a is immediately downstream (65 metres) of the crossing (50 metre straight-line distance). The remaining wetlands are located on the banks of Emigrant Creek with No. 96 around 234 metres, No. 97 440 metres and No. 98 250 metres (straight-line distance) from the project boundary. Downstream distances for these wetlands from the project crossing of Emigrant Creek are 1.5 kilometres (No. 96), 2 kilometres (No. 97) and 2.7 kilometres (No.98).

Figure 3-60 - Aquatic habitats, wetlands and threatened fish within the study area - Section 1

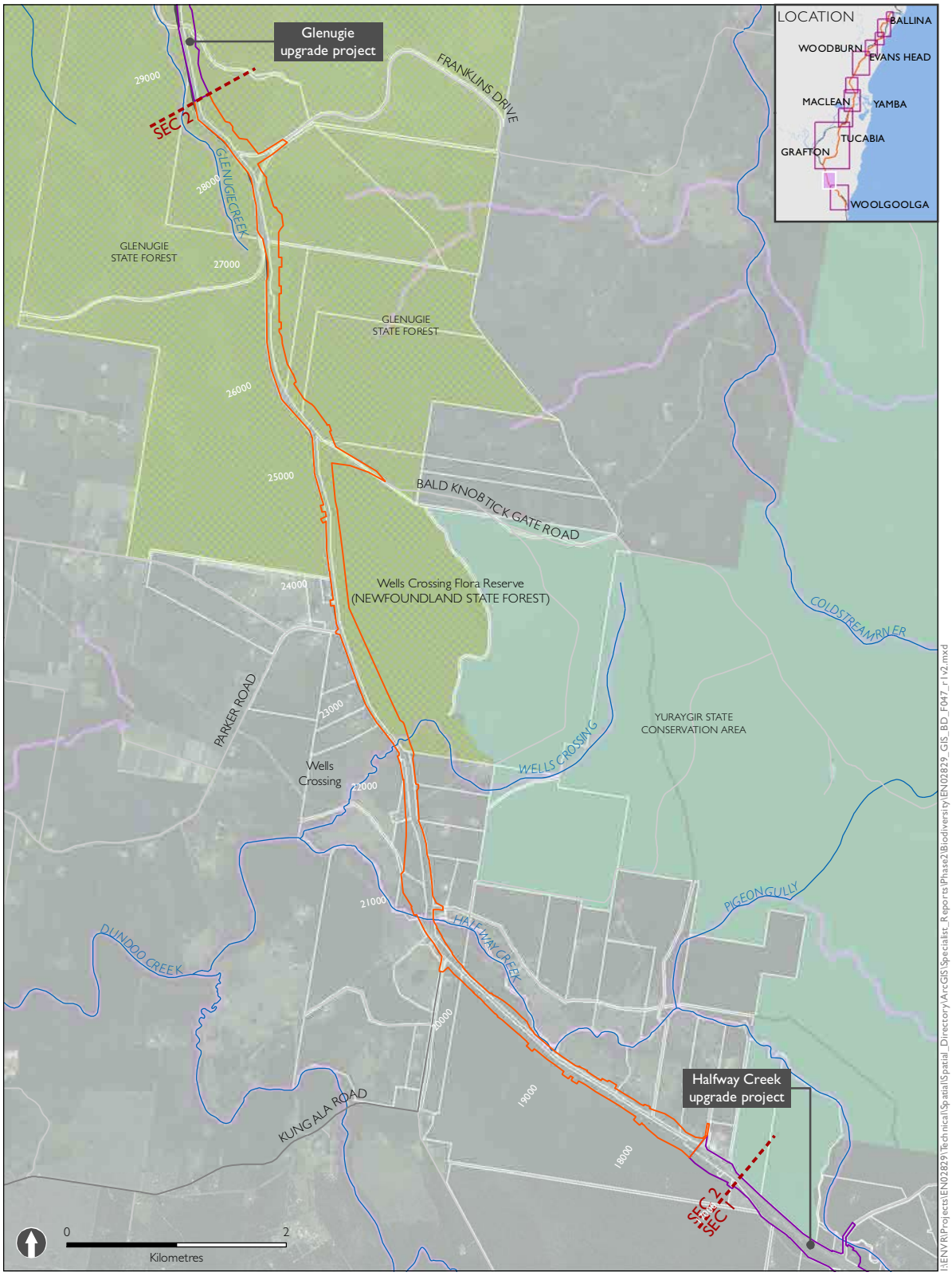


The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Named waterways

Key fish habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (from targeted surveys)

National Park
Nature Reserve / State Conservation Area
State Forest
Nationally Important & SEPP 14 wetlands

Figure 3-61 - Aquatic habitats, wetlands and threatened fish within the study area - Section 2



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Named waterways

Key fish habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (from targeted surveys)

National Park
Nature Reserve / State Conservation Area
State Forest
Nationally Important & SEPP 14 wetlands

Figure 3-62 - Aquatic habitats, wetlands and threatened fish within the study area - Section 3

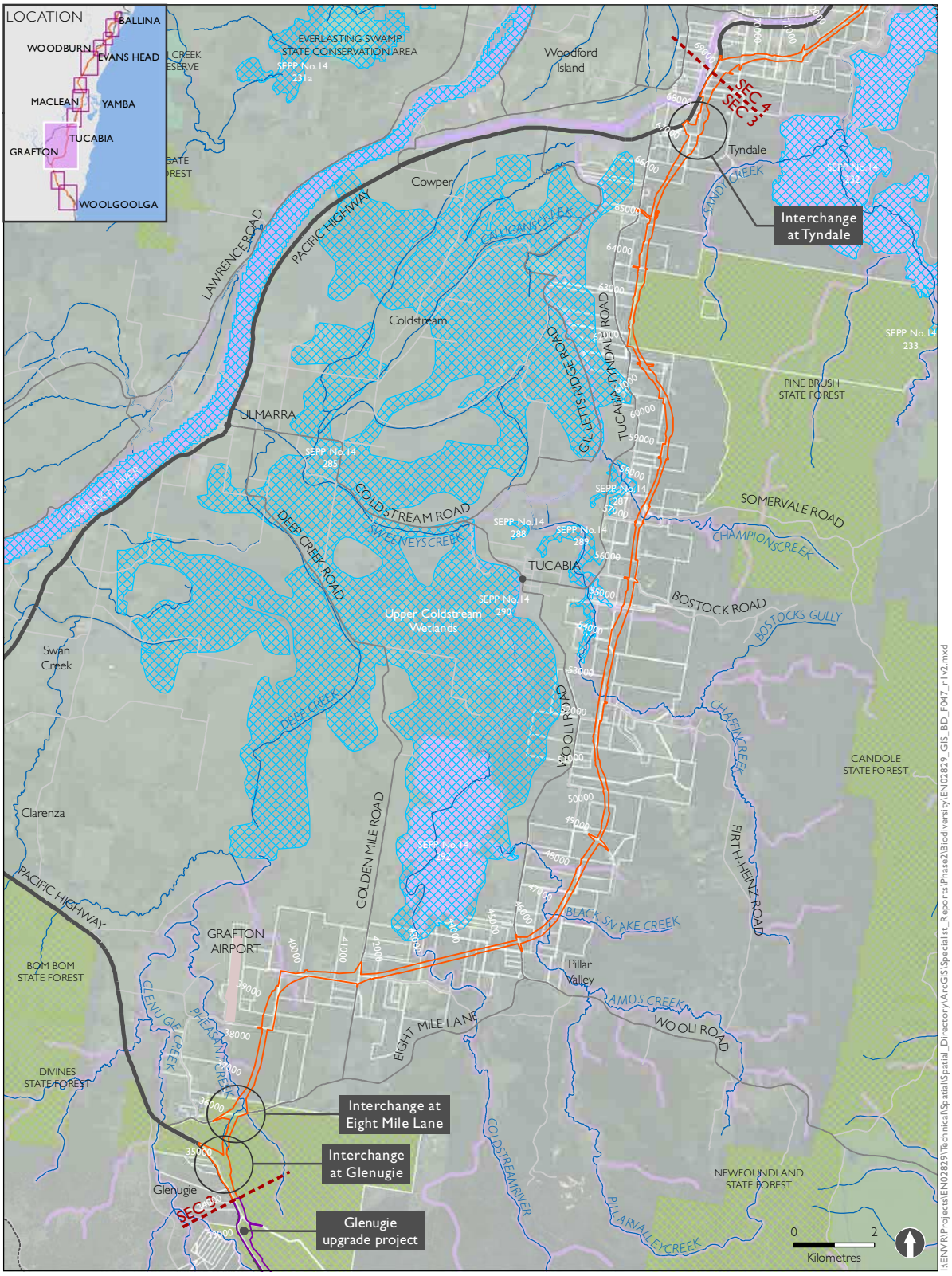


Figure 3-63 - Aquatic habitats, wetlands and threatened fish within the study area - Section 4

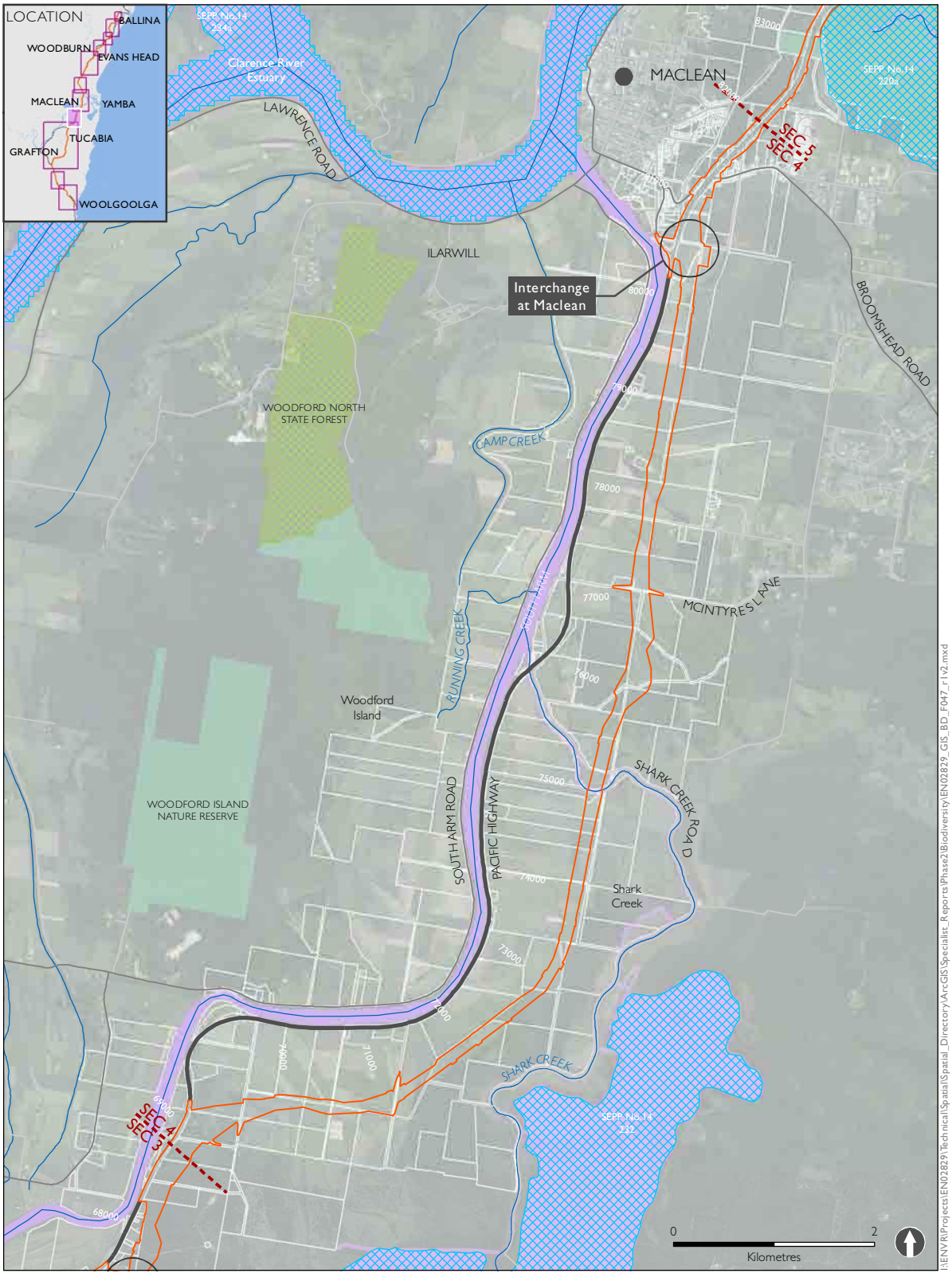
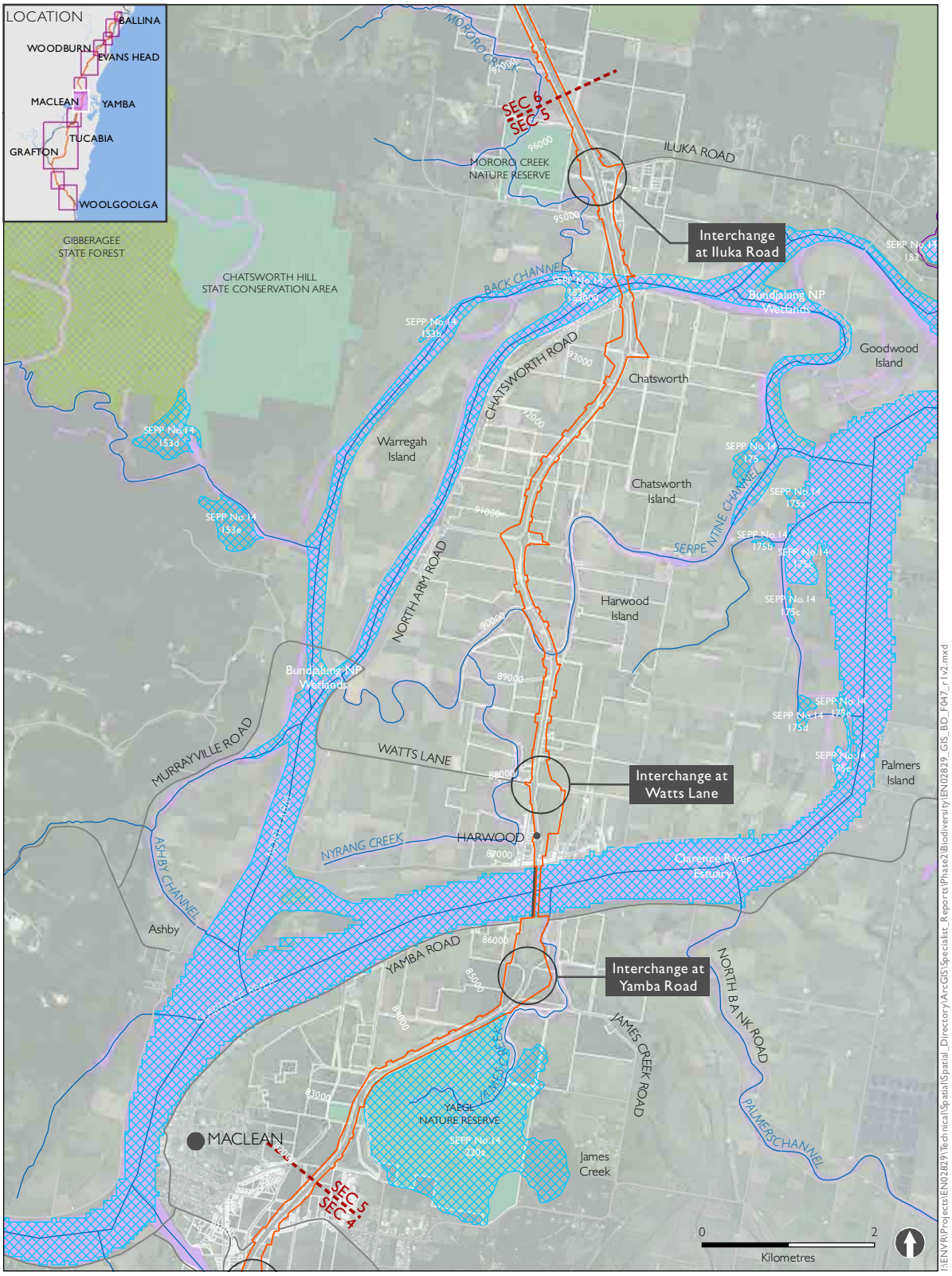


Figure 3-64 - Aquatic habitats, wetlands and threatened fish within the study area - Section 5

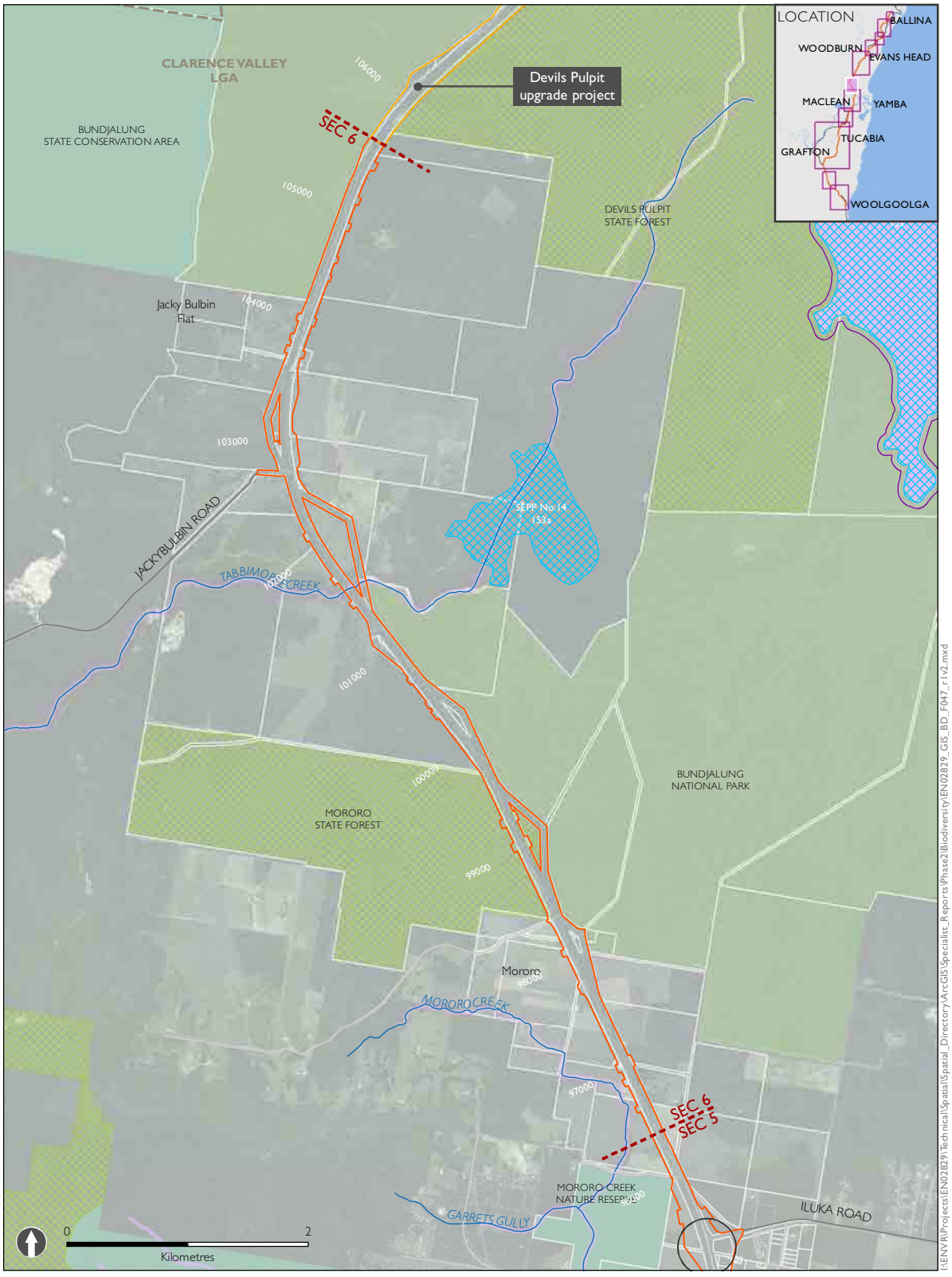


The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Named waterways

Key fish habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (from targeted surveys)

National Park
Nature Reserve / State Conservation Area
State Forest
Nationally Important & SEPP 14 wetlands

Figure 3-65 - Aquatic habitats, wetlands and threatened fish within the study area - Section 6

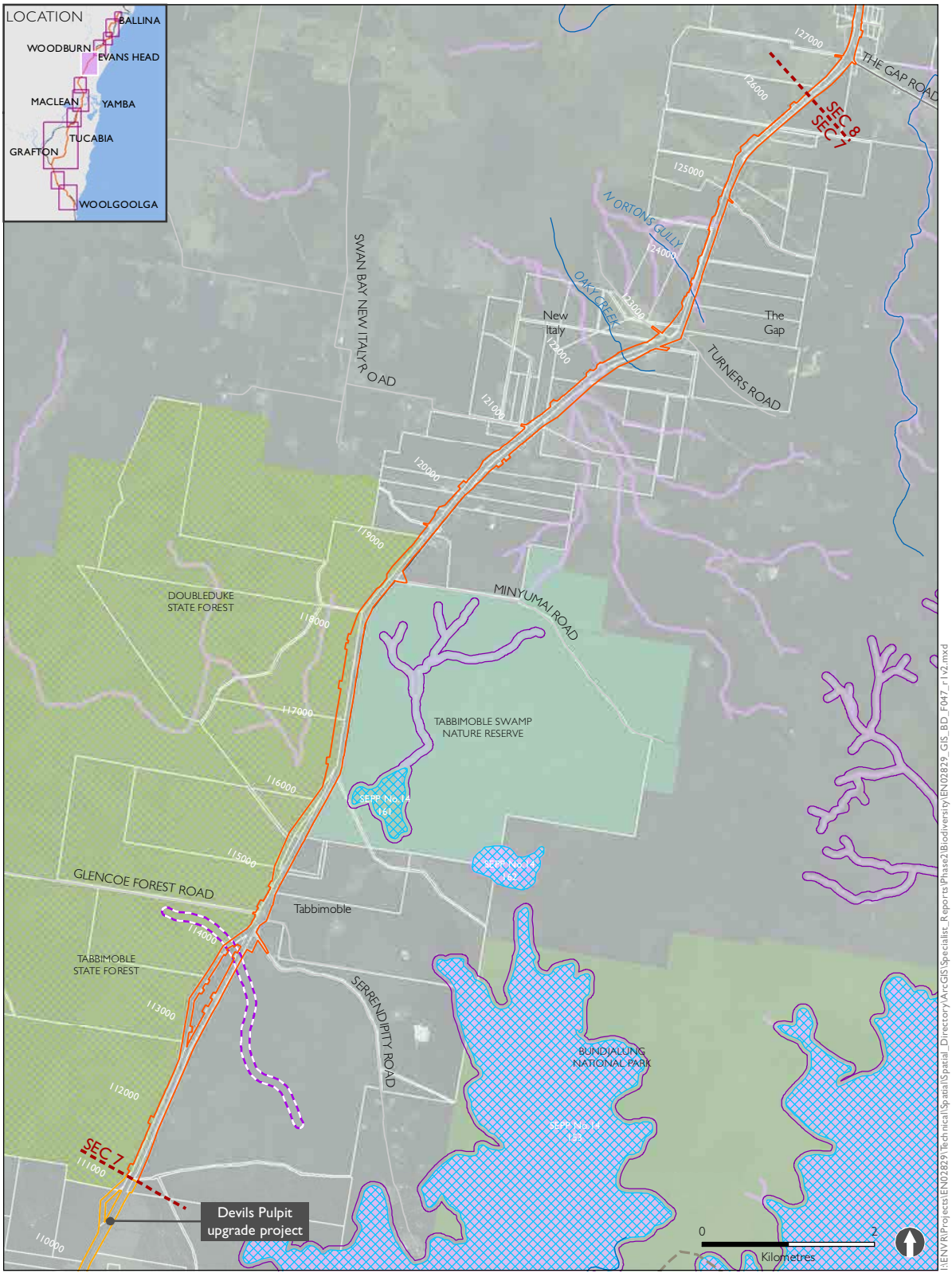


The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Named waterways

Key fish habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (from targeted surveys)

National Park
Nature Reserve / State Conservation Area
State Forest
Nationally Important & SEPP 14 wetlands

Figure 3-66 - Aquatic habitats, wetlands and threatened fish within the study area - Section 7



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Named waterways

Key fish habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (NSW DPI)
Oxleyan Pygmy Perch habitat (from targeted surveys)

National Park
Nature Reserve / State Conservation Area
State Forest
Nationally Important & SEPP 14 wetlands

Figure 3-67 - Aquatic habitats, wetlands and threatened fish within the study area - Section 8

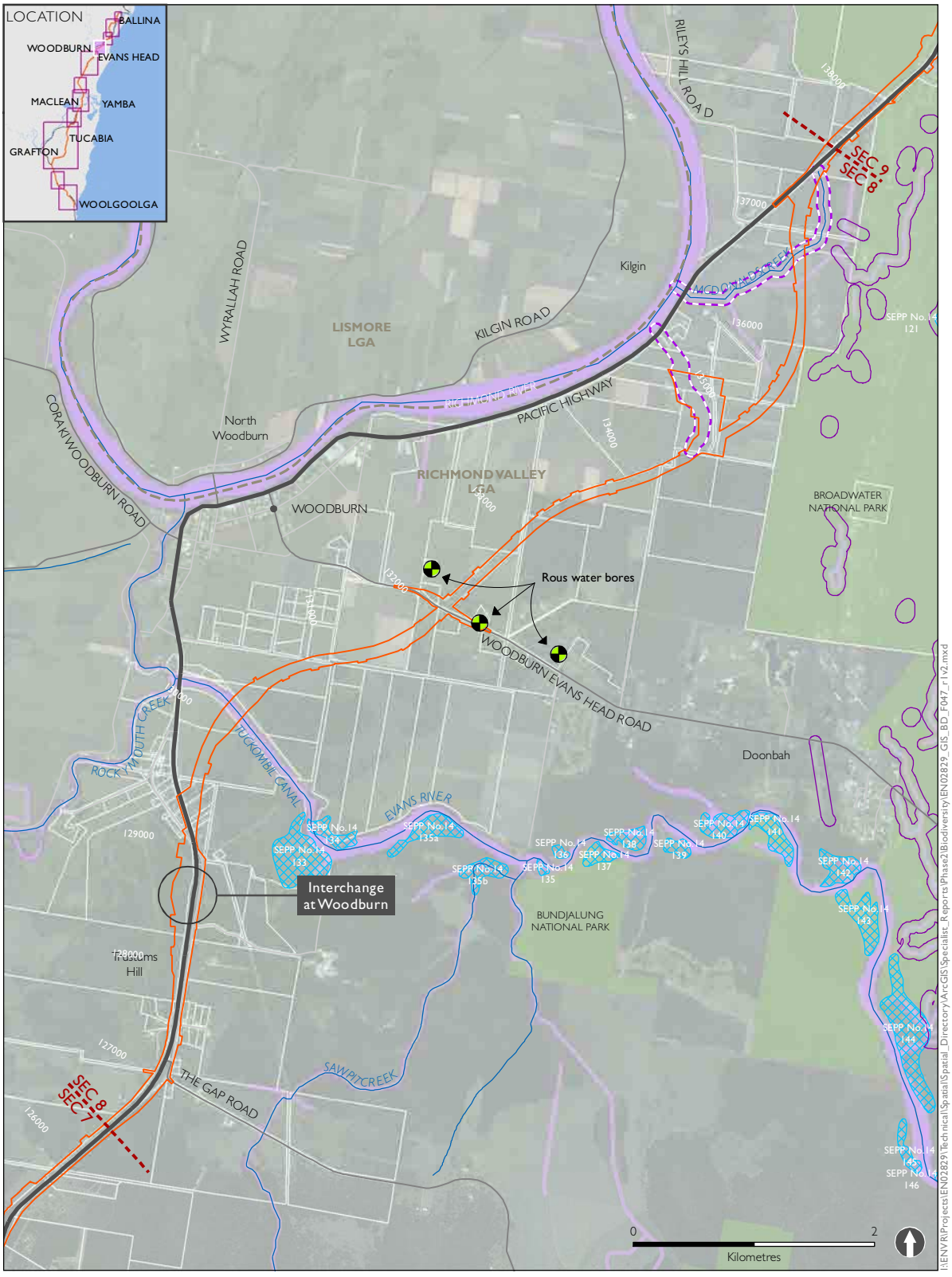
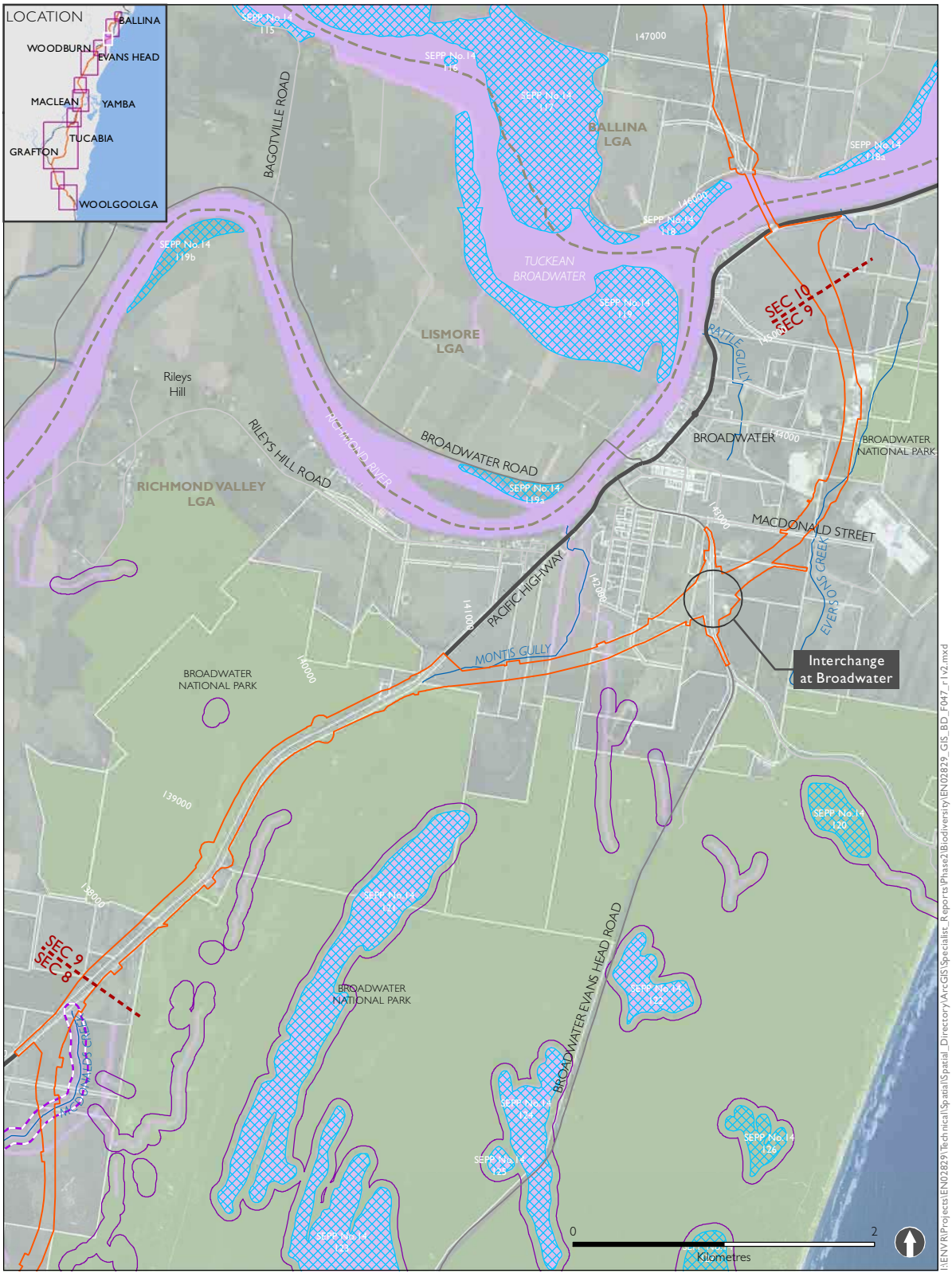


Figure 3-68 - Aquatic habitats, wetlands and threatened fish within the study area - Section 9



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- The project
- Upgrade completed to dual carriageway
- Upgrade under construction
- Existing Pacific Highway
- Named waterways
- Key fish habitat (NSW DPI)
- *Oxleyan Pygmy Perch* habitat (NSW DPI)
- *Oxleyan Pygmy Perch* habitat (from targeted surveys)
- National Park
- Nature Reserve / State Conservation Area
- State Forest
- Nationally Important & SEPP 14 wetlands

Figure 3-69 - Aquatic habitats, wetlands and threatened fish within the study area - Section 10

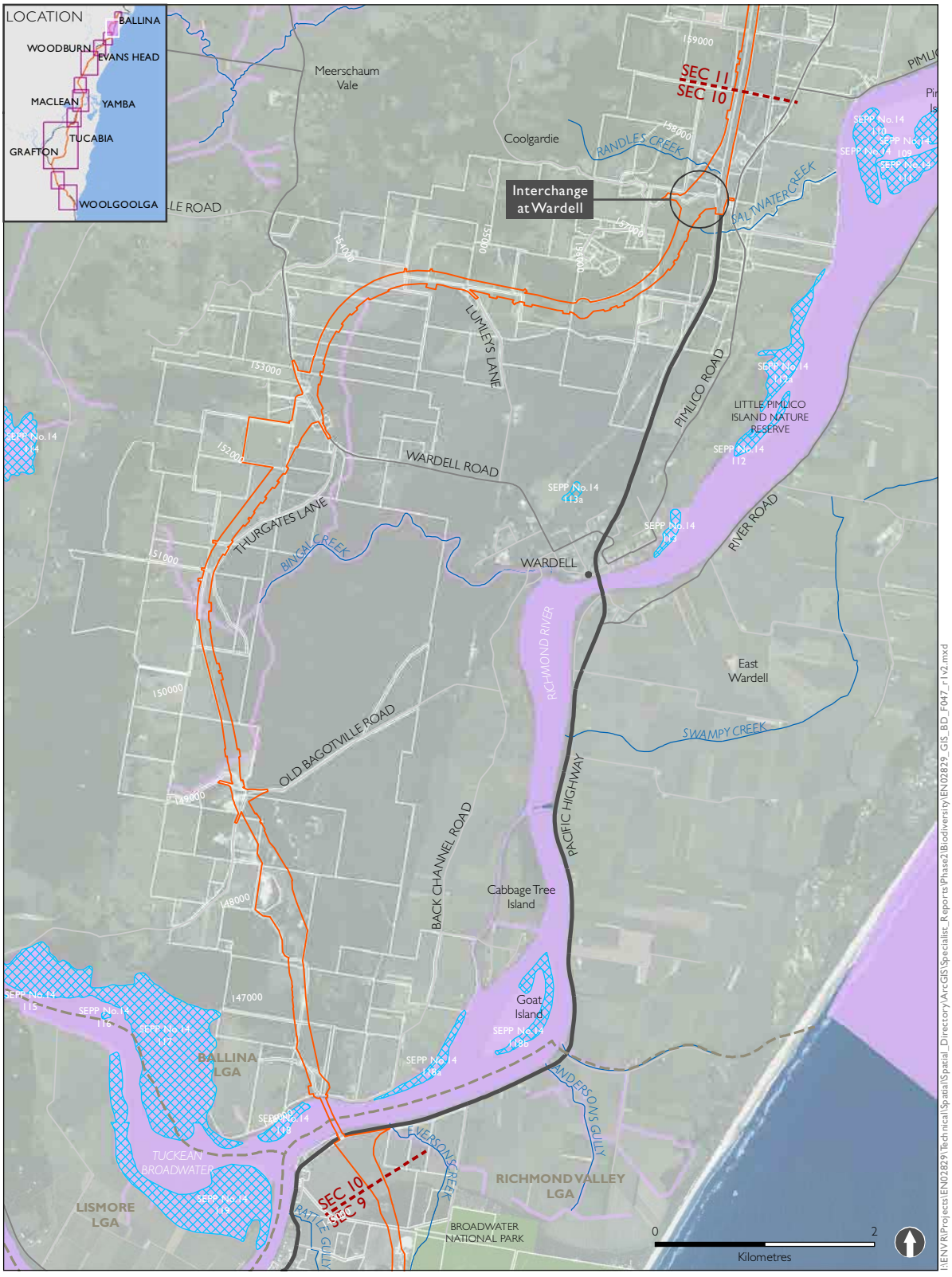
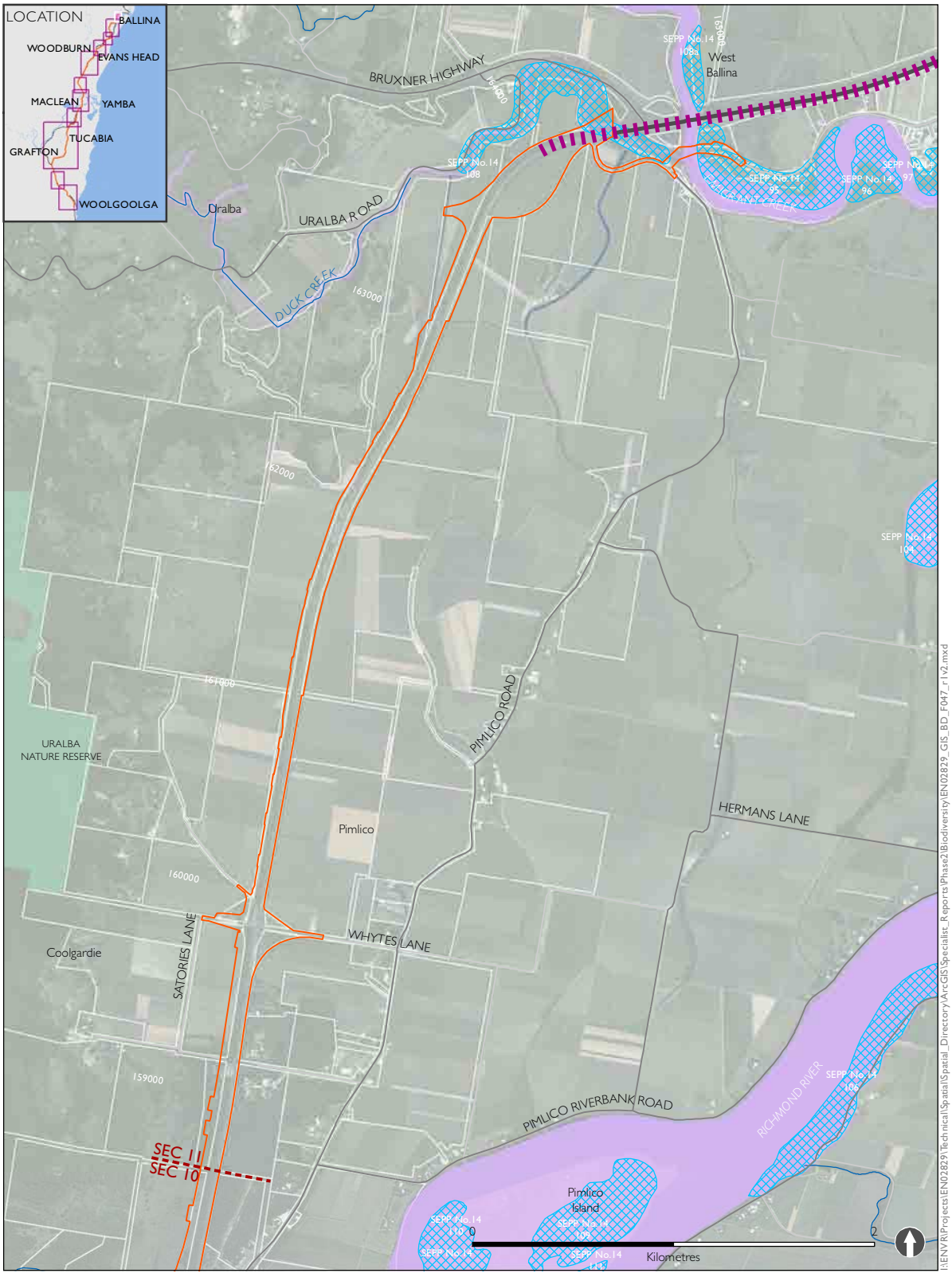


Figure 3-70 - Aquatic habitats, wetlands and threatened fish within the study area - Section 11



3.8. Fish species

A total of 25 freshwater and estuarine fish species and 7 species of decapods (crabs, prawns and shrimp) were recorded in the study area. The total list of aquatic fauna identified from the surveys is presented in Appendix I, which includes the Oxleyan Pygmy Perch listed as endangered under the EPBC Act and FM Act. Further discussion on this species is provided in Section 3.9.6

Other species recorded in the region which are not listed under NSW legislation but should be considered ecologically significant are Olive Perchlet (*Ambassis agassizii)* and Freshwater Catfish (*Tandanus tandanus).* The western population of the Olive Perchlet (*Ambassis agassizii*) from the Murray-Darling catchment is listed as endangered, while coastal populations are not listed. Due to these species' reduced numbers, and unclear taxonomy in northern waters, NSW Fisheries (1999) recommends that species and their habitats be given special consideration in planning decisions throughout their NSW distribution. The Olive Perchlet was recorded in Coldstream Creek (Section 3), McDonalds Creek (Section 8) and upstream of the project boundary at Tuckean Broadwater (Section 10).

The introduced fish species, Plague Minnow (*Gambusia holbrooki*) was most abundant in the study area, and was the only species consistently recorded across the entire study area. Much of the data presented from ecological surveys undertaken 2006 to 2012 identifies presence of fish and limited abundance data was collected for discussing diversity. Further discussion on abundance and common or rare aquatic fauna is discussed in RTA (2006-2011).

3.9. Species, populations and communities of conservation concern

The following sections identify the NSW and Commonwealth listed (under TSC Act, FM Act and EPBC Act) species, populations and ecological communities identified from ecological surveys undertaken 2006 to 2012 within the study area.

3.9.1. Threatened ecological communities

Six threatened ecological communities (TEC) listed under the TSC Act are present in the project boundary (Table 3-12). These are listed under Schedule 1 Part 3 of the Act as endangered ecological communities. One of these communities, Lowland Rainforest in subtropical Australia, has also been listed as Critically Endangered under the EPBC Act. There are no other nationally endangered ecological communities. The distribution of listed ecological communities in the region is widespread, although heavily fragmented and generally associated with the coastal and floodplain habitats being traversed by the project, many of which have been cleared for agriculture and development. The distribution of listed ecological communities in the study area is mapped previously in Figure 3-6 to Figure 3-31.

Table 3-12 Descriptions and approximate area of Threatened Ecological Communities (TSC Act and EPBC Act) in project boundary

Threatened Ecological Community	Status	General notes on characteristics and distribution
Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin & South East Corner bioregions	Endangered (TSC Act)	• Associated with periodic or semi-permanent inundation by freshwater, with some minor saline influence in certain wetlands. Typically occur on silts, muds or humic loams in depressions, flats, and drainage lines on floodplains, generally below 20 metres elevation • Found in Sections 3, 4, 8 and 9 identified as the BioMetric vegetation type: Coastal floodplain sedgelands, rushlands, and forblands.
Sub-tropical coastal floodplain forest of the NSW North Coast Bioregion	Endangered (TSC Act)	• Includes numerous Eucalypt-dominated vegetation associations on periodically inundated alluvial flats, drainage lines and river terraces on floodplain areas. Generally occur below 50 m elevation and varies in structure from the open forests and woodlands of the adjoining elevated lands. The composition primarily determined by flooding regimes and the texture, nutrient and moisture content of the soil, in addition to latitude and history of disturbance. The combination of features that distinguish this community from other endangered ecological communities on the coastal floodplains are: • A dominant mixed eucalypt canopy • The presence of rainforest elements as scattered trees or understorey plants • The relatively low abundance or sub-dominance of Swamp Oak Casuarina glauca and Paperbark (*Melaleuca spp*.) • The relatively low abundance of Swamp Mahogany (*Eucalyptus robusta*) • The prominent groundcover of soft-leaved forbs and grasses • Patchily distributed throughout the central or marginal parts of the floodplains and sandy flats, habitats where flooding is periodic and soils are rich in silt and sand, sometimes humic, and show little influence of saline groundwater • Found in all project sections and identified as the following BioMetric vegetation types: Forest Red Gum - Swamp Box of the Clarence Valley lowlands of the North Coast, Narrow-leaved Red Gum woodlands of the lowlands of the North Coast and Swamp Box swamp forest of the coastal lowlands of the North Coast.

Threatened Ecological Community	Status	General notes on characteristics and distribution
Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Endangered (TSC Act)	• Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated flats and drainage lines of floodplain areas. Generally occur below 20 m (though sometimes up to 50 m) elevation. In some areas the tree stratum is low and dense, so that the community takes on the structure of scrub, fernland and tall reedland or sedgeland, where trees may be sparse or sometimes absent • Characterised by a relatively dense tree canopy dominated by Swamp Mahogany and / or Broad-leaved Paperbark. A relatively infrequent occurrence of other Eucalypts may occur, as well as Swamp Oak or Swamp Turpentine (*Lophostemon suaveolens*) and the occasional presence of rainforest elements (eg scattered trees or understorey plants) and the prominence of large sedges and ferns in the groundcover. Soils are usually waterlogged, stained black or dark grey with humus, and show little influence of saline ground water • Found in all project sections except Section 11 and identified as the following BioMetric vegetation types: Paperbark swamp forest of the coastal lowlands of the North Coast and Swamp Mahogany swamp forest of the coastal lowlands of the North Coast
Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	Endangered (TSC Act)	• Generally occurs below 20 m (rarely above 10 m) elevation • Associated with grey-black clay-loams and sandy loams, where groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains • The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees • Found in Sections 1, 3-5, and 8-11 identified as the BioMetric vegetation type: Swamp Oak swamp forest of the coastal lowlands of the North Coast.

Threatened Ecological Community	Status	General notes on characteristics and distribution
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion Lowland Rainforest of Sub-tropical Australia	Endangered (TSC Act) Critically Endangered (EPBC Act)	• Occurs on fertile soils in lowland river valleys (only occurring as small remnants on the NSW North Coast, with less than 1000 hectares in total thought to remain • In an undisturbed state, it exhibits a closed canopy of rainforest tree species with high species richness and structural complexity. In disturbed stands (as are represented in the study area) the canopy continuity may be broken, or the canopy may have introduced tree species, such as Camphor Laurel, or sometimes smothered by exotic vines • Common representative rainforest tree species include: Rough-leaved Elm (*Aphananthe philippinensis*), Bangalow Palm (*Archontophoenix cunninghamiana*), Cabbage Tree Palm (*Livistona australis*), Figs (*Ficus spp*.), Pepperberry (*Cryptocarya obovata*), Lilly Pilly (*Syzygium spp.)* and Weeping Lilly Pilly (*Waterhousea floribunda*) • Found in Sections 3 and 8-11 identified as the BioMetric vegetation types: Black Bean - Weeping Lilly Pilly riparian rainforest of the North Coast, Hoop Pine - Yellow Tulipwood dry rainforest of the North Coast and White Booyong - Fig subtropical rainforest of the North Coast.
Coast Cypress Pine shrubby open forest of the North Coast Bioregion	Endangered (TSC Act)	• Has a closed to open canopy of Coastal Cypress Pine (*Callitris columellaris*), which may be mixed with eucalypts, wattles, banksias and/or rainforest trees, and an open to sparse understorey of shrubs, sedges and herbs • Found on coastal sand plains, north from the Angourie area. Currently known occurrences of the community are generally within 35 kilometres of the coast and below 100 metres elevation • Found in Sections 8-11 identified as the BioMetric vegetation type: Coast Cypress Pine shrubby open forest of the North Coast Bioregion.

3.9.2. Emu populations in the NSW North Coast Bioregion

The surveys and background research conducted between Wells Crossing and Iluka Road in the Clarence Valley area (sections 3 and 4) identified the endangered emu population in the NSW North coast bioregion and Port Stephens LGA (Schedule 1, Part 2 of the NSW TSC Act) as present and being at risk due to the project.

Distribution

Within the North Coast bioregion the endangered emu population comprises three sub-populations, the largest centred on Yuraygir National Park and surrounds on the southern side of the Clarence River estimated at between 80-120 individuals. The remaining sub-populations occur north of the river centred on Bundjalung National Park and Bungawalbin Nature Reserve (Main Camp). Table 3-13 describes the current status of the three sub-populations and their proximity to the project boundary.

Table 3-13 Details of the three described coastal emu sub-populations in the mid north coast (source NPWS annual survey results 2002-2012; G.Hart pers.comm)

Sub-population and range	Predicted population size (2011)	Intersection with project boundary
Yuraygir sub-population**:** Yuraygir National Park and surrounds, including Clarence River floodplain north to Gulmarrad-Maclean, and south to Red Rock.	Largest group has remained stable at between 80-120 individuals for last 10 years.	Intersects with section 3 and 4
Bundjalung sub population: Bundjalung National Park from Iluka to Evans Head	Smallest population, only 20 birds estimated in 2006. No emus counted in 2010 census, current population unknown and considered possibly extinct.	Not directly affected
Bungawalbin sub-population: Bungawalbin Nature Reserve and National Park, main camp	Estimated at < 60 birds.	Not directly affected

The habitat of the coastal emu population has been reduced and fragmented as a result of clearing for agriculture and rural and urban development, with a consequent decline in and isolation of these sub-populations. The degree of past and current interaction between the sub-populations is not known. The smaller northern sub-populations in Bundjalung and Bungawalbin are possibly less viable in the long-term compared to the larger Yuraygir population due their smaller size.

The larger Yuraygir population occupies much of the coastal strip of Yuraygir National Park to the east of the project as well as surrounding contiguous areas in the Sandon and Brooms Head area in the north and Wooli Road and Pillar Valley in the south as far as Red Rock. Further details on the population and likely impacts from the project are discussed in Section 4.

Genetic pilot study

A report on the DNA collection and extraction pilot is provided as Appendix K. The pilot trialled various DNA extraction protocols on three source materials; feather, scat and tissue (positive control). A total of 97 scat samples and 83 feather samples were collected in the field. Tissue and complete feather samples was collected by NPWS from roadkill birds (Gina Hart *pers.comm*) and used as a control sample.

The tissue and feather derived DNA was yielded in detectable quantities while scat-derived DNA of emu origin was not readily identified. These data suggest that scat collection is not a viable method of collecting DNA due to the emus diet and structure of the dung. While feather derived DNA is suitable, the quality of DNA varied according to feather characteristics. Large complete feathers (from the roadkill birds) consistently yielded high quantities and better quality DNA than smaller incomplete feathers (collected from the field survey along barbed wire fences).

The most efficient and widespread method of collecting feathers during the survey was from barbed wire fences where these intersected transects. However the feathers collected from fences provided poor results in terms of the extraction of DNA with less than three per cent of the samples providing usable DNA.

Therefore while the DNA extraction was successful for whole feathers collected from roadkill animals, this collection method will not assist in meeting the original objectives of the study, which were to:

- Estimate the total population size and structure and the range of group territories through replicated surveys designed as a Mark Capture Recapture study
- Identify the proportion of the population using habitat around the alignment in the Pillar Valley / Tucabia area and therefore potentially impacted by the project (using the total population size data)
- Identify if the road is creating a barrier to emu movements and genetic segregation of individuals.

In order to obtain answers to these questions the field collection method must rely on repeat sampling and identification of individuals from either scats or small feather samples to use a Capture Mark Recapture approach at estimating population size and group range. The results of the field pilot revealed a less than three per cent success rate for extraction of DNA and so cannot meet these objectives of the study.

What the genetic pilot did reveal was a high degree of genetic relatedness in the emu population across the geographic range of the samples analysed, including birds across the range from Red Rock to Pillar Valley, Brooms Head and north of the Clarence River. These data suggest the population is widespread across the entire known range and not separated into genetically isolated smaller sub-populations and that there is likely to be dispersal of emus into and out of the identified sub-group ranges.

Landowner interviews

The landowner interviews identified a number of consistent observations regarding the seasonal movements, diet and behaviour of emus in the study area (Table 3-14). These relate to the presence of emus around Pillar Valley and Tucabia during the spring and summer seasons. Emus particularly favour recent planting crops of soy beans, oats or rye grass around cane and grazing paddocks and easily pass through stock fencing, such as three strand or four strand fences.

Nesting in the study area has only been observed twice and both locations were on higher ground to the east of the project boundary. The wetland habitats are frequented for foraging but not nesting. Emus are inquisitive, particularly around new structures, houses and people.

Table 3-14 Summary of landowner interviews

No.	Observed seasonal movements comments	Nesting	Observed food plants	Fences and other observed behaviours / general comments
1.	Only found on property in spring and summer. Frequent open country, sparsely wooded with grassy understorey. Have not observed crossing Wooli Road, however large groups observed west of Whites Bridge on the flat ground on edge of swamp, in Aug-Sept. Also frequent lower Pillar Valley Creek and Black Snake Creek	Located a nest at the western side of Chaffin Hill, 400 m north of Chaffin Creek. Nesting occurred above the flood line in late spring	Rye grass, favour short green pick in paddocks after fire. Burns in spring or early summer	Observed emus passing through three and five strand stock fences easily Inquisitive of new things, houses and people.
2.	Only found around Pillar Valley in spring and summer. Observed crossing Wooli Road. Move across the Coldstream River over to Travelling Stock Route and wetlands along Wants Lane and Tea-tree farms. Observed crossing near Whites Bridge to access wetlands. Observed crossing Wooli Road near powerline easement through Conners property around Chaffin Creek 500 m north of Firth Heinz Road. Also cross 500-1000 m north of Tallowwood Lane to the Coldstream River through Kratz More emu observations south of Tucabia around Pillar Valley then north to Tyndale	Located a nest on crown lease land 300 m north of Mitchells Road. Nesting occurred above the flood line in late spring.	Sword Sedge (*Gahnia* spp.) *Eleocharis* spp.	Observed emus passing under stock fences, using depressions in the ground and lining up to pass under at the same location Inquisitive of new things

No.	Observed seasonal movements comments	Nesting	Observed food plants	Fences and other observed behaviours / general comments
3	Only found on property in spring and summer. Frequent open plains around lower Pillar Valley creek and Whites Bridge and Black Snake Creek in August-September. Mentioned staying around Ellis Swamp in drought of 1995. More activity south of Tucabia to Pillar Valley then north to Tucabia. Frequent the low heath country Observed emu groups on Sommervale Flat property at the upper reaches of Shark Creek		Bangalow Palm seeds *Lambertia* spp Soy bean crops Large group of 50 seen on his property feeding on planted oats crop	Observed emus passing through three and five strand fences Inquisitive. High mortality rate of chicks. Has observed large clutches gradually dwindle and suspects that some birds get separated from the group and are picked off by dogs and wedge-tailed eagles
4	No information		Bangalow Palm *Lomandra* spp observed feeding on native figs	Bounce into fence when encountered on the road Seen crossing the road north of Tallowwood Lane
5	Birds regularly observed in spring and summer on his cane property. This is mostly adult males with groups of juvenile offspring, Appears to be important for raising young in the open cane country. Up to fifteen birds regularly seen in 2012.		Soy bean crops Inkweed	Pass through stock fences easily Not disturbed by machinery, tractors of harvesters and will continue to forage undisturbed. Has seen them cross the bridge over Shark Creek Road Can be regular in their movements, sleep in the swamp forest and emerge into the open country at dawn. Rarely use habitat up close the highway

No.	Observed seasonal movements comments	Nesting	Observed food plants	Fences and other observed behaviours / general comments
6	Don't forage close the highway or cross the road to get to his other land But do cross McIntyres Lane regularly Seen groups of up to 15 on his lawn and backyard. Photos look like juveniles and adult males Confirms makes and chicks come to his property Seen to come from direction of Green Hill to the southeast		Soy bean crops	Pass through stock fences easily Inquisitive
7	Emus regularly pass over Green Hill from the south east and move along tree line, cross over McIntyres Lane and access the cane fields Most common in spring and summer. Observed adult male with 14 chicks this year, not sure if it was two clutches		Soy beans Lablab bean Inkweed	Abundant feathers on their back fence evidence that emus regularly cross through the fence and come over Green Hill Not seen near the highway

3.9.3. Threatened flora

Threatened flora in project boundary

A total of 15 threatened flora species were identified from ecological surveys undertaken 2006 to 2012 in proximity to the project boundary. Details on these species, including where possible, population size and distribution in relation to the project boundary, is presented in Table 3-15 and mapped in Figure 3-71 to Figure 3-79.

Further details on seven of these species follows, each of these were found to have relatively large populations occurring in the vicinity of the project boundary, which included *Angophora robur, Melaleuca irbyana, Eucalyptus tetrapleura, Arthraxon hispidus, Cyperus aquatilis, Maundia triglochinoides, and Lindsaea incisa* (refer to Table 3-15). The remaining species occur as either isolated individuals or small restricted populations within proximity to the project boundary.

Table 3-15: Threatened flora identified in relation to the project boundary

Species	Status	Distribution and abundance in study area	Confirmed
Angophora robur Sandstone Rough-barked Apple	Vulnerable (TSC Act and EPBC Act)	Estimated to be around 9,000 individuals over 105 hectares based on detail surveys comprising direct counts of individuals within the boundary and detailed mapping of the distribution. The known regional distribution is estimated to comprise 152,712 individuals over around 1818 hectares and the predicted distribution is estimated to consist of 618,912 individuals over around 7368 hectares. For further description on the surveys for *Angophora robur* refer to detail in section 0. The population within and adjacent to the project boundary represents the known eastern distribution of the species.	Sections 3 and 4
Arthraxon hispidus Hairy-joint Grass	Vulnerable (TSC Act and EPBC Act)	Several large populations between Coolgardie Road and Lumley's Lane. The known area of occupation of the species is 20.8 hectares.	Section 10
Archidendron hendersonii White Laceflower	Vulnerable (TSC Act)	11 individuals in subtropical rainforest north of Coolgardie Road.	Section 10
Cryptocarya foetida Stinking Cryptocarya	Vulnerable (TSC Act and EPBC Act)	A total of 17 individuals were recorded in and surrounding the project boundary in Section 10 north of Coolgardie Road.	Section 10
Cyperus aquatilis Water Nutgrass	Endangered (TSC Act)	Previously recorded at six locations in Sections 6 and 7 (Ecos Environmental 2007). During supplementary surveys (January 2012) it could only be relocated at Mororo State Forest where a relatively large population (c. 80 plants) was previously recorded. Other records in the study area include a grazed paddock area south of Jacky Bulbin Road (c. 18 plants), a disturbed drainage line north of Glencoe Road (9 plants) and several locations where only 1-3 individuals were recorded including Tabbimoble Floodway No. 2 and around 1 kilometres north in Red Gum forest grading into Scribbly Gum. Individuals in the project boundary are potentially part of a larger population surrounding the project boundary.	Section 6, 7
Endiandra hayesii Rusty Rose Walnut	Vulnerable (TSC Act and EPBC Act)	Recorded in a patch of subtropical rainforest north of Coolgardie Road comprising a total of five larger individuals and three juveniles.	Section 10
Endiandra muelleri subsp. bracteata Green-leaved Rose Walnut	Endangered (TSC Act)	Recorded to the west of the project boundary at Maclean Section 5 and at Section 10. Recorded in a patch of subtropical rainforest north of Coolgardie Road comprising one large individual and three juveniles. A total of eight individuals are recorded throughout project boundary.	Section 5 and 10

Species	Status	Distribution and abundance in study area	Confirmed
Eucalyptus tetrapleura Square-fruited Ironbark	Vulnerable (TSC Act and EPBC Act)	Several known populations surrounding the existing Pacific Highway in Section 2. The population extends into the surrounding private properties and state forest including Wells Crossing Flora Reserve. The population is estimated to comprise 1,213 individuals in proximity to the project boundary, comprising around 14.5 hectares of known habitat.	Section 2
Grevillea quadricauda Four-tailed Grevillea	Vulnerable (TSC Act and EPBC Act)	Recorded in the project boundary at two different locations in Section 3. It occurs in moderate abundance comprising two sub-populations totalling 46 individuals. One of these sub-populations is part of a larger population to the east of the project boundary consisting of at least an additional 200 individuals.	Section 3
Lindsaea incisa Slender Screw Fern	Endangered (TSC Act and EPBC Act)	Populations were found along the edges of drainage swales with sandy soils. The four locations comprise: A large population extending into the boundary on the western side of the highway opposite Lemon Tree Road in Section 1. A small patch 12 metres upstream to the east of the project boundary on an elevated area in the centre of Halfway Creek, Section 2. A large population 20 metres downstream to the west of the project boundary near Tucabia in section 3. A large population extending into the project boundary in Mororo State Forest in Section 6.	Sections 1-3 and 6
Macadamia tetraphylla Rough-shelled Bush Nut	Vulnerable (TSC Act)	Recorded to the west of the project boundary at Maclean (Section 5), surrounding the boundary at Section 10 and 11 and to the south of the boundary at Section 1. The largest population comprises 68 individuals recorded south of Coolgardie Road in Section 10 including juveniles and mature trees.	Section 1, 5 and 10-11
Maundia triglochinoides	Vulnerable (TSC Act)	This species has been recorded at 15 locations, of which 12 are within the project boundary, consisting of: Large populations in Halfway Creek and Wells Crossing, Section 1. Moderate to large sized populations in the Coldstream River, Chaffin Creek, unnamed tributaries south of Bostock Road, near Tallowwood Lane and east of Tucabia Road in Section 3. Small to moderate populations in Section 7 at Tabbimoble Floodway Number 1 and 2, and several tributaries that cross the highway north of New Italy.	Sections 1-3, 7 and 10
Melaleuca irbyana Weeping Paperbark	Endangered (TSC Act)	Recorded in the project boundary at New Italy (Section 7) and surrounding the project boundary at Pillar Valley (Section 3). The population at New Italy contains around 800 individuals comprising 250 trees (>3 m high) and 550 saplings and suckers, occurring over an area that extends north-south for around 200 metres and east-west for 100 metres (Ecos Environmental 2007).	Sections 3 and 7
Olax angulata Square-stemmed Olax	Vulnerable (TSC Act)	One individual has been recorded in the project boundary north of Halfway Creek at Section 2. The fleshy fruit of this species is potentially attractive to fruit-eating bird species and has dispersed into the project boundary from surrounding populations.	Section 2

Species	Status	Distribution and abundance in study area	Confirmed
Prostanthera cineolifera Singleton Mint Bush	Vulnerable (TSC Act and EPBC Act)	Occurs at a single location on Tabbimoble Creek south of Tullymorgan Road. Inhabits a narrow belt of deep, sandy soil along Tabbimoble Creek.	Section 7

Figure 3-71 Threatened flora species - section 2

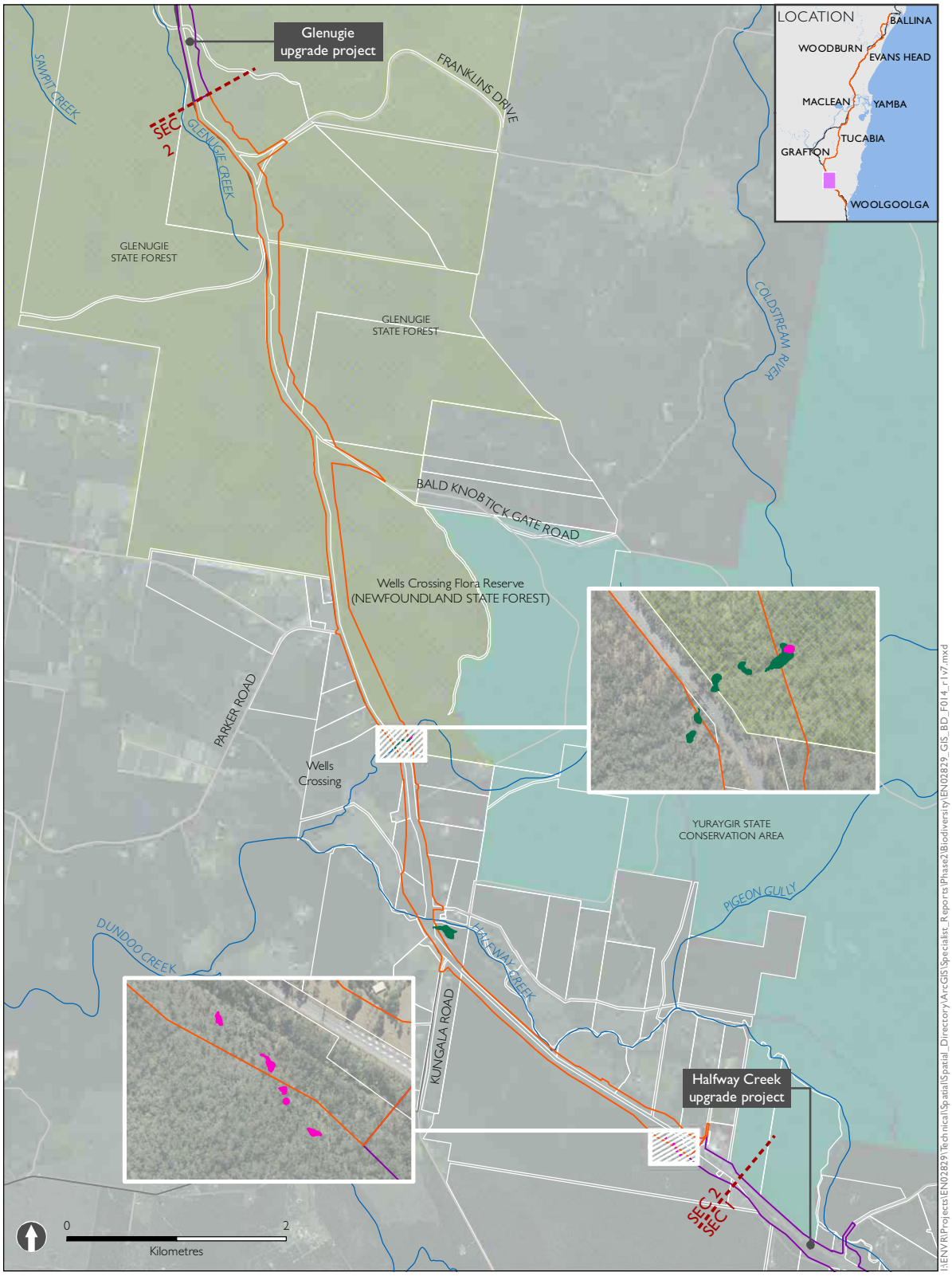


Figure 3-72 Threatened flora species - section 2

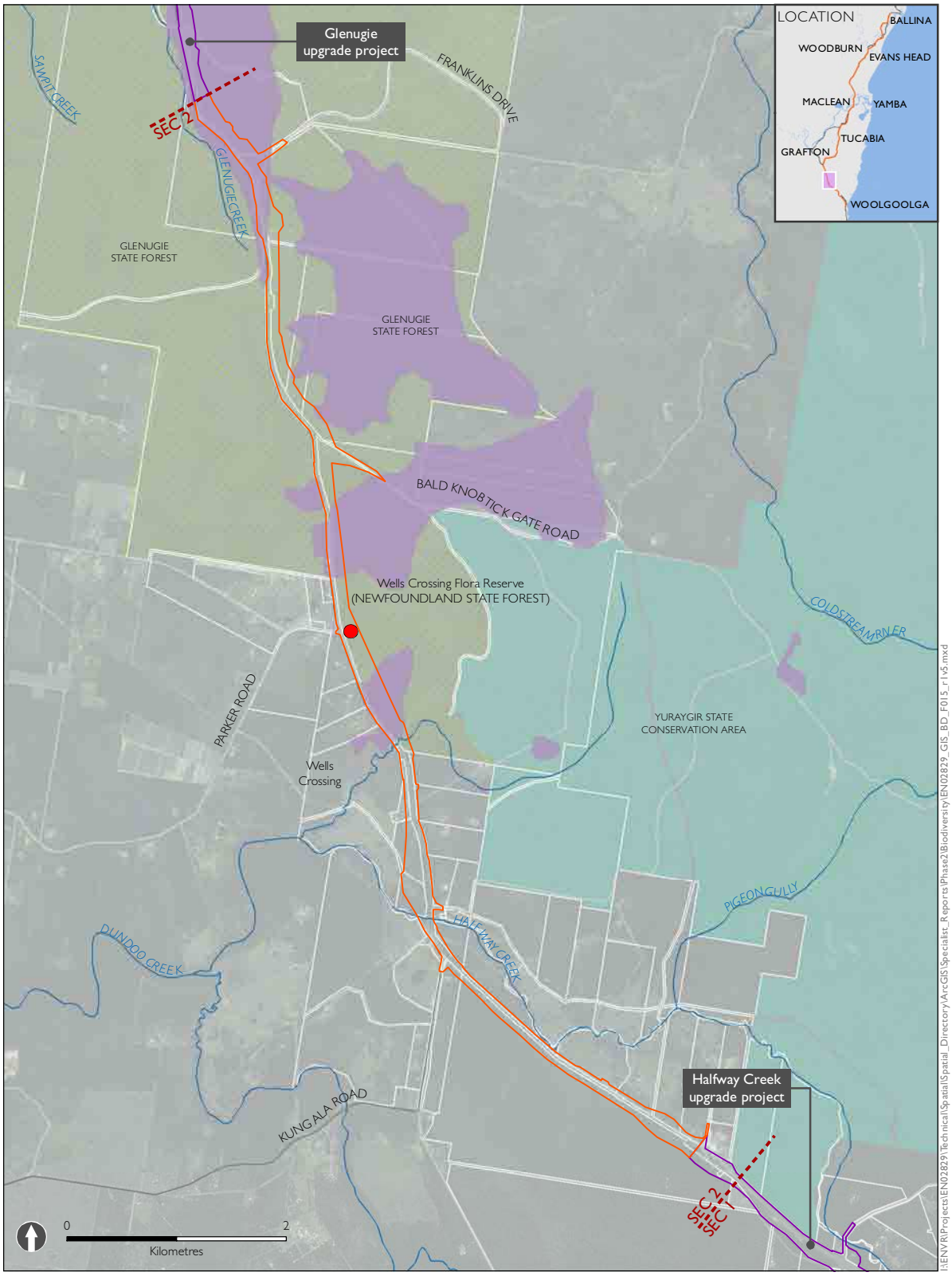
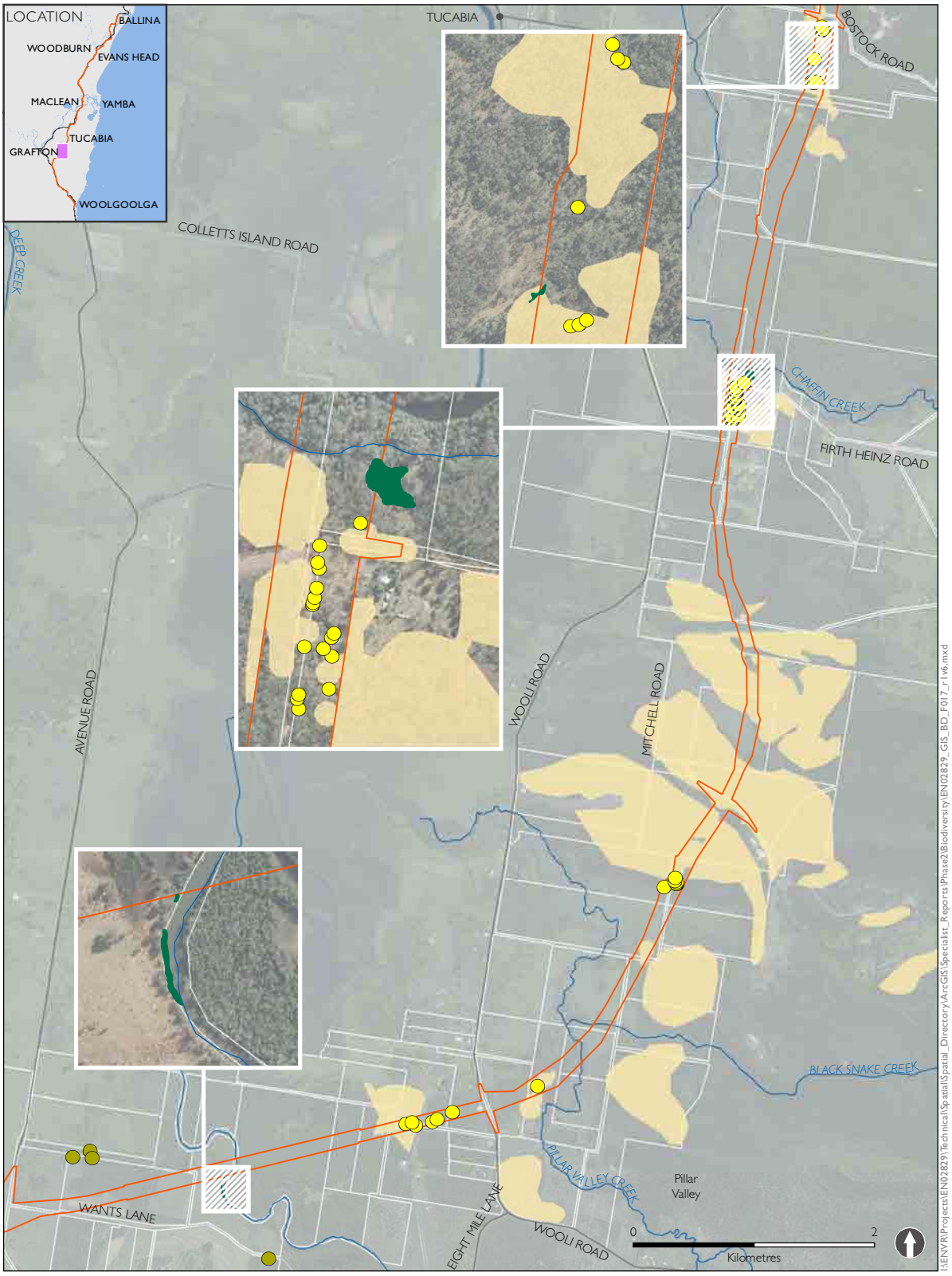


Figure 3-73 Threatened flora species - section 3



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

Threatened flora
Angophora robur
Melaleuca irbyana
Angophora robur (larger cluster)
Maundia triglochinoides

Figure 3-74 Threatened flora species - section 3

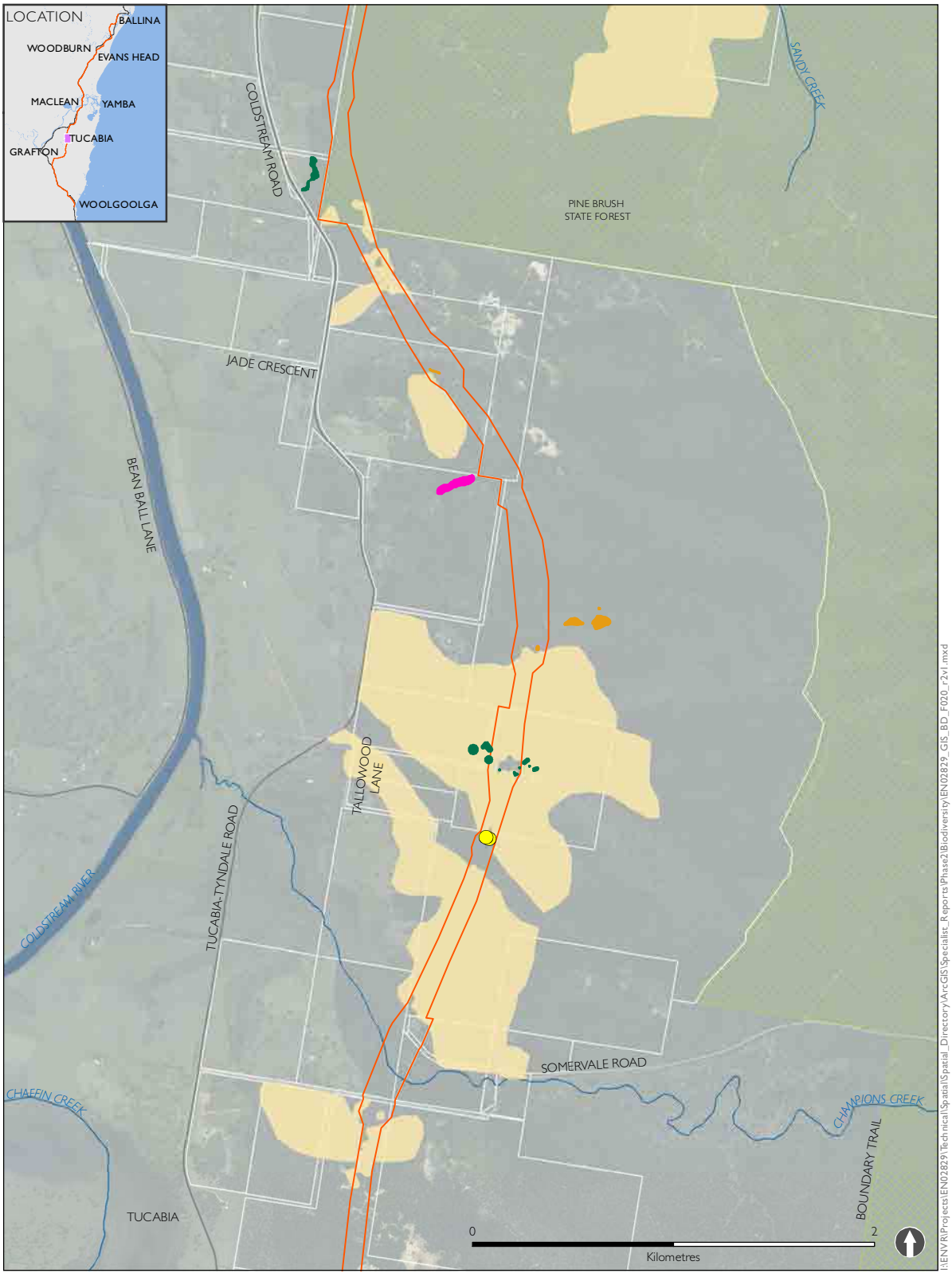


Figure 3-75 Threatened flora species - section 3 and 4

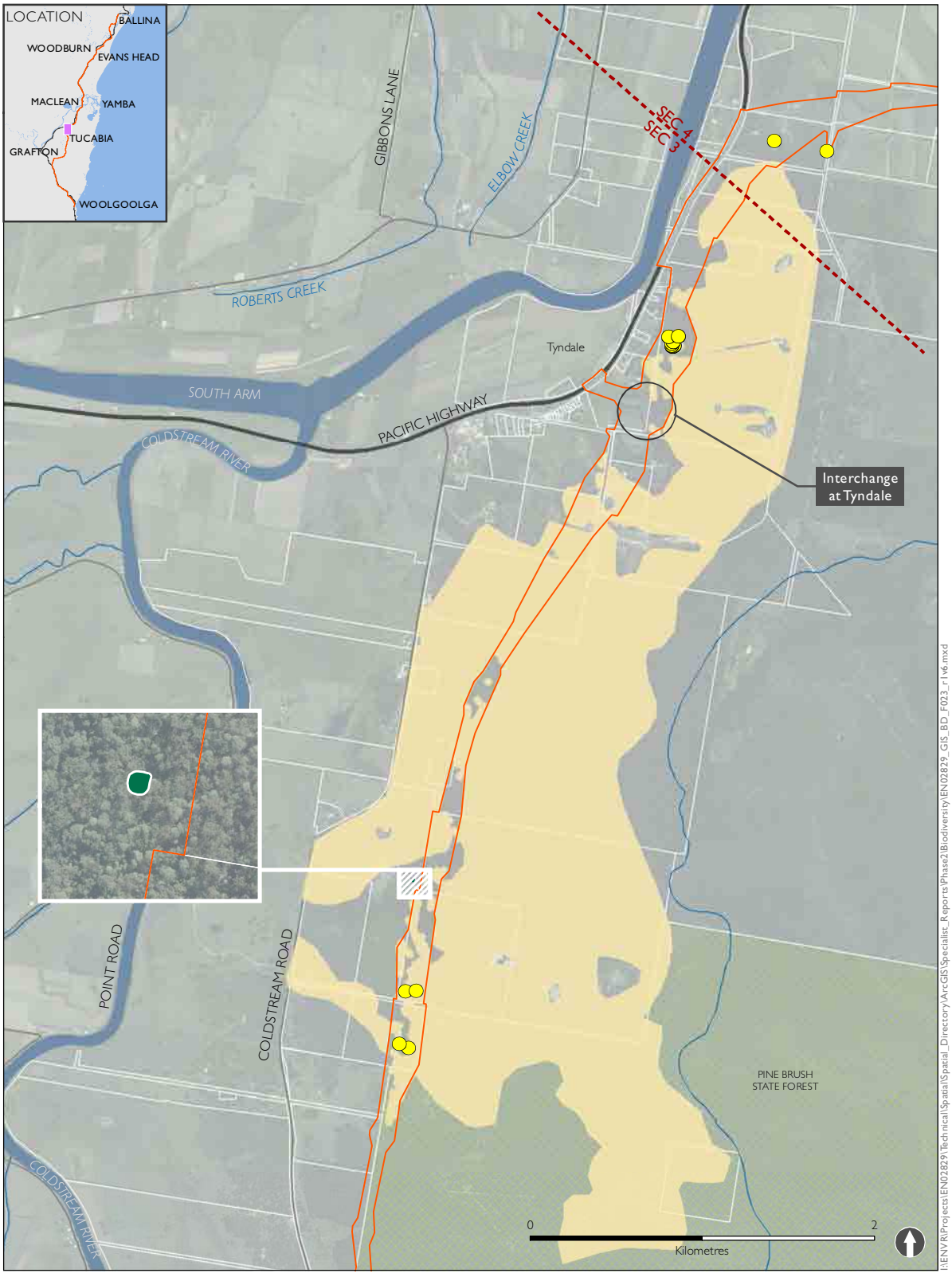


Figure 3-76 Threatened flora species - section 6

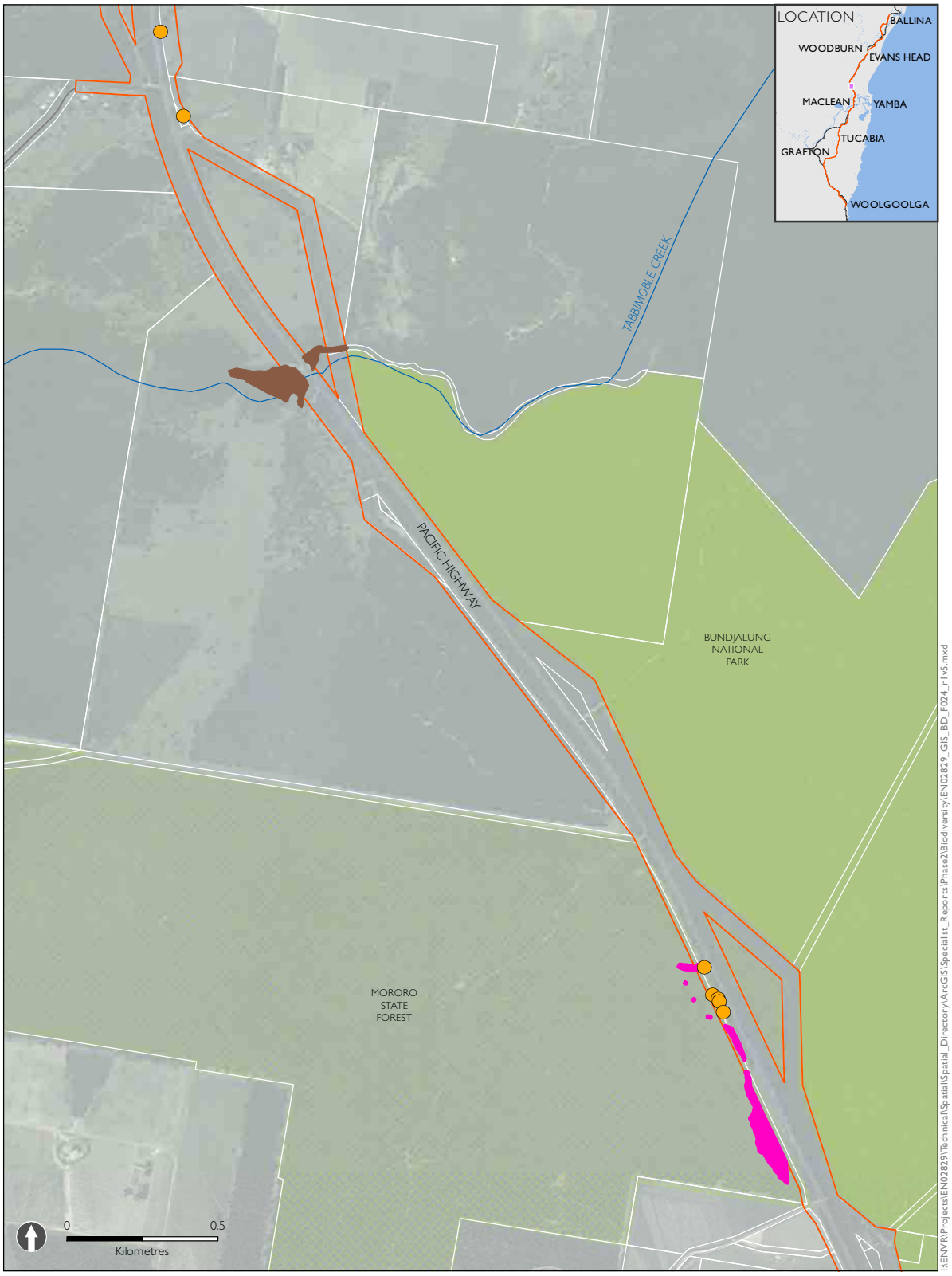


Figure 3-77 Threatened flora species - Devils Pulpit and section 7

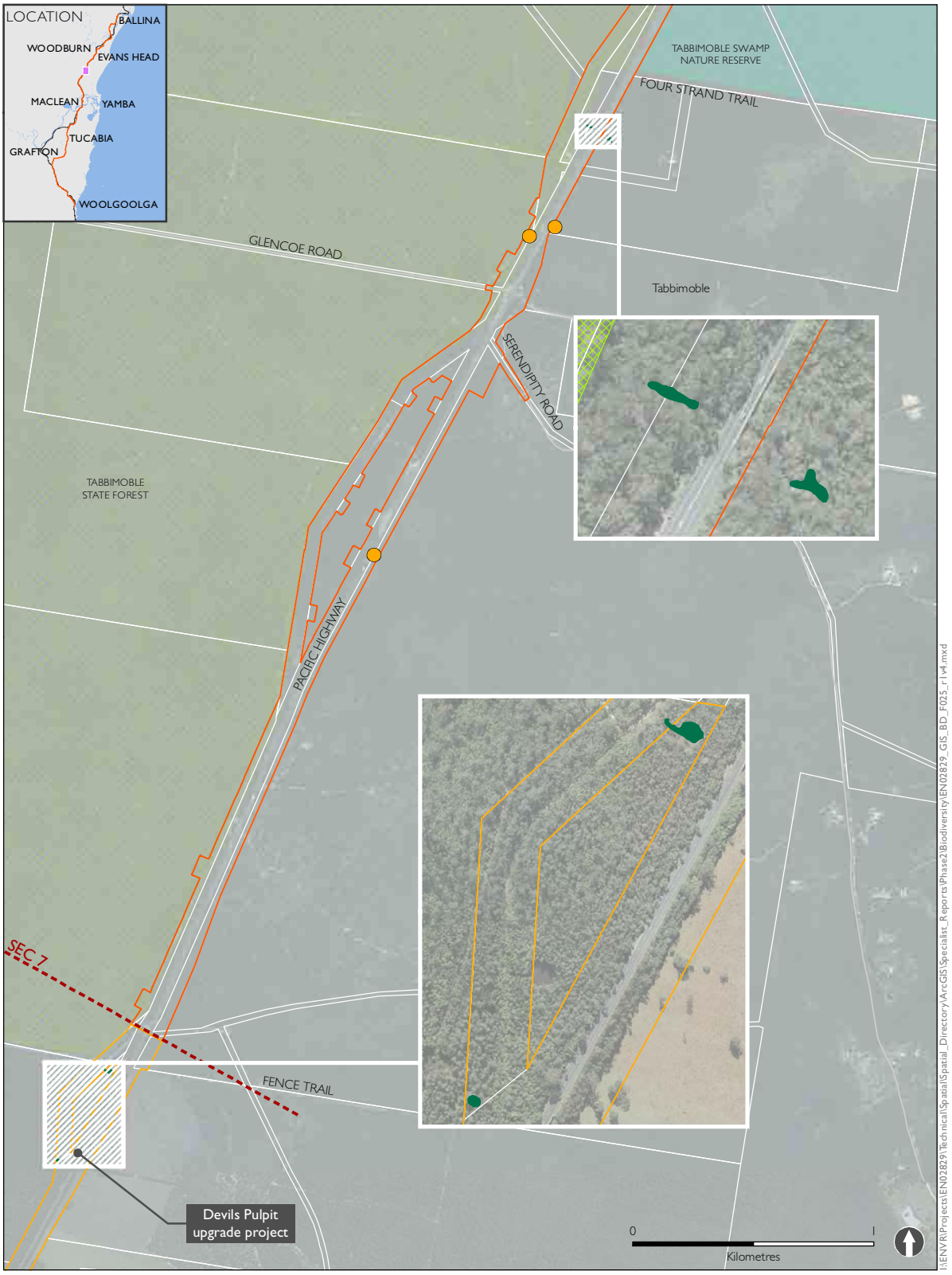


Figure 3-78 Threatened flora species - section 7 (New Italy area)

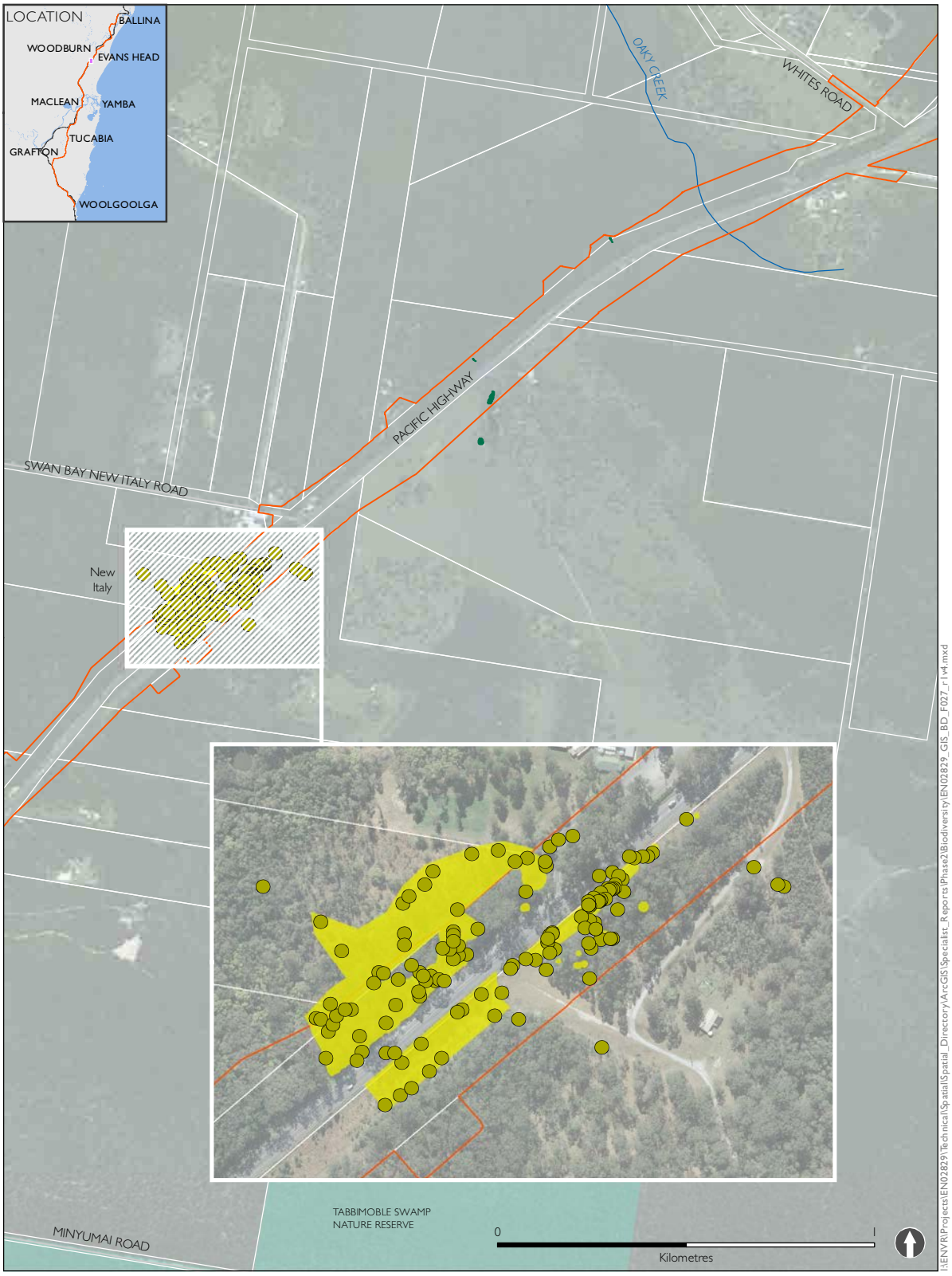
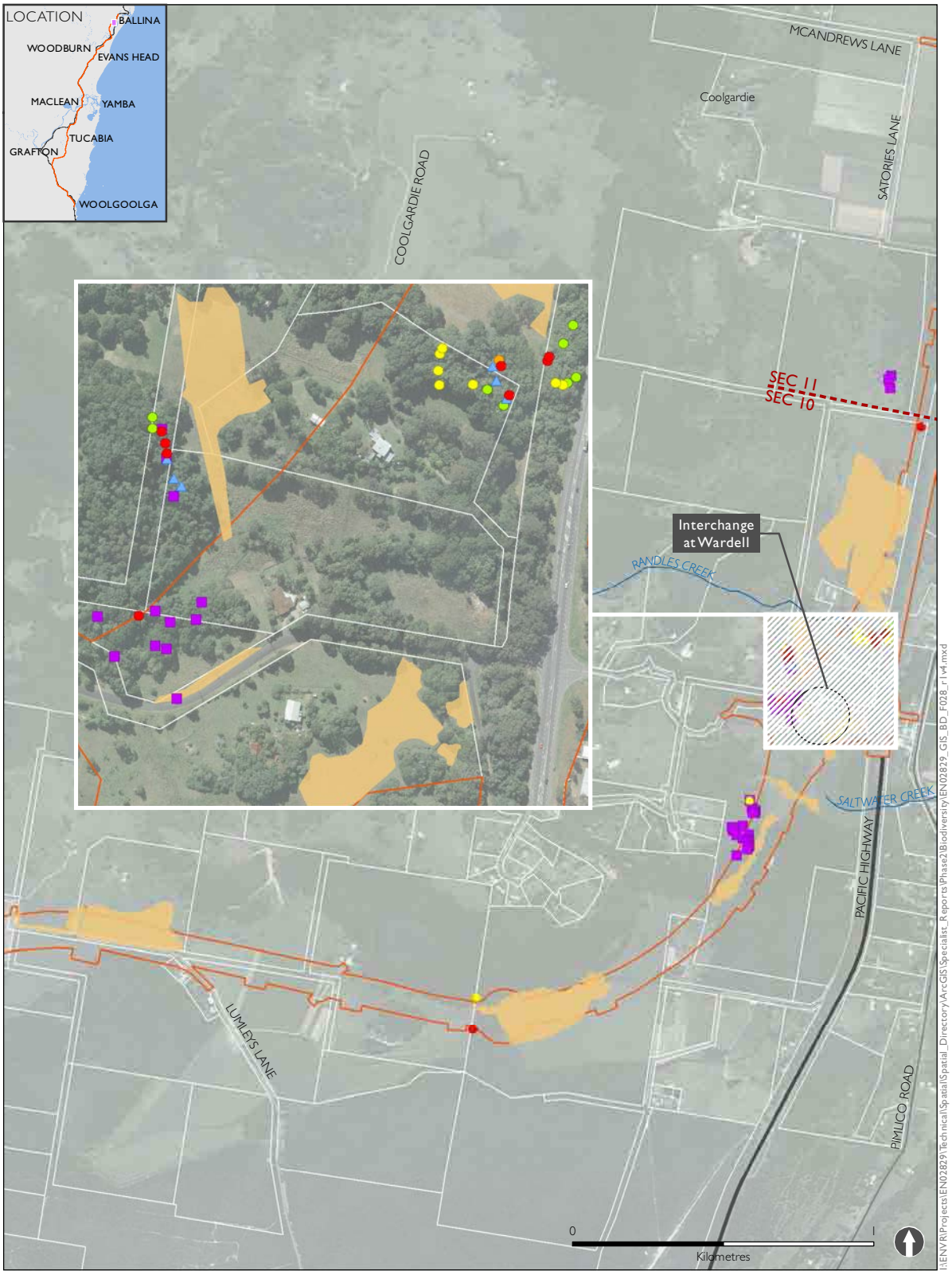


Figure 3-79 Threatened flora species - section 10



Sandstone Rough-barked Apple (*Angophora robur*)

Description

Sandstone Rough-barked Apple (*Angophora robur*) is a small to medium tree species restricted to sandy soils on sandstone in the New South Wales North Coast Bioregion. It has paired leaves with gnarled limbs. It grows up to 20 metres tall with rough grey bark and is distinguished by its unusually large leaves, which are up to 18 centimetres long and 7.5 centimetres wide. The leaves may be rather bristly and are paler underneath. The white, clustered flowers are followed by large, ribbed fruits up to 1.6 centimetres long and wide.

Distribution

It was originally thought to be restricted to an area north-west of Coffs Harbour and north-west of Grafton, with an isolated occurrence further west near Nymboida. Additional populations have since been recorded to the north-east and south-east of Grafton along the Summervale Range (refer to Figure 3-80).

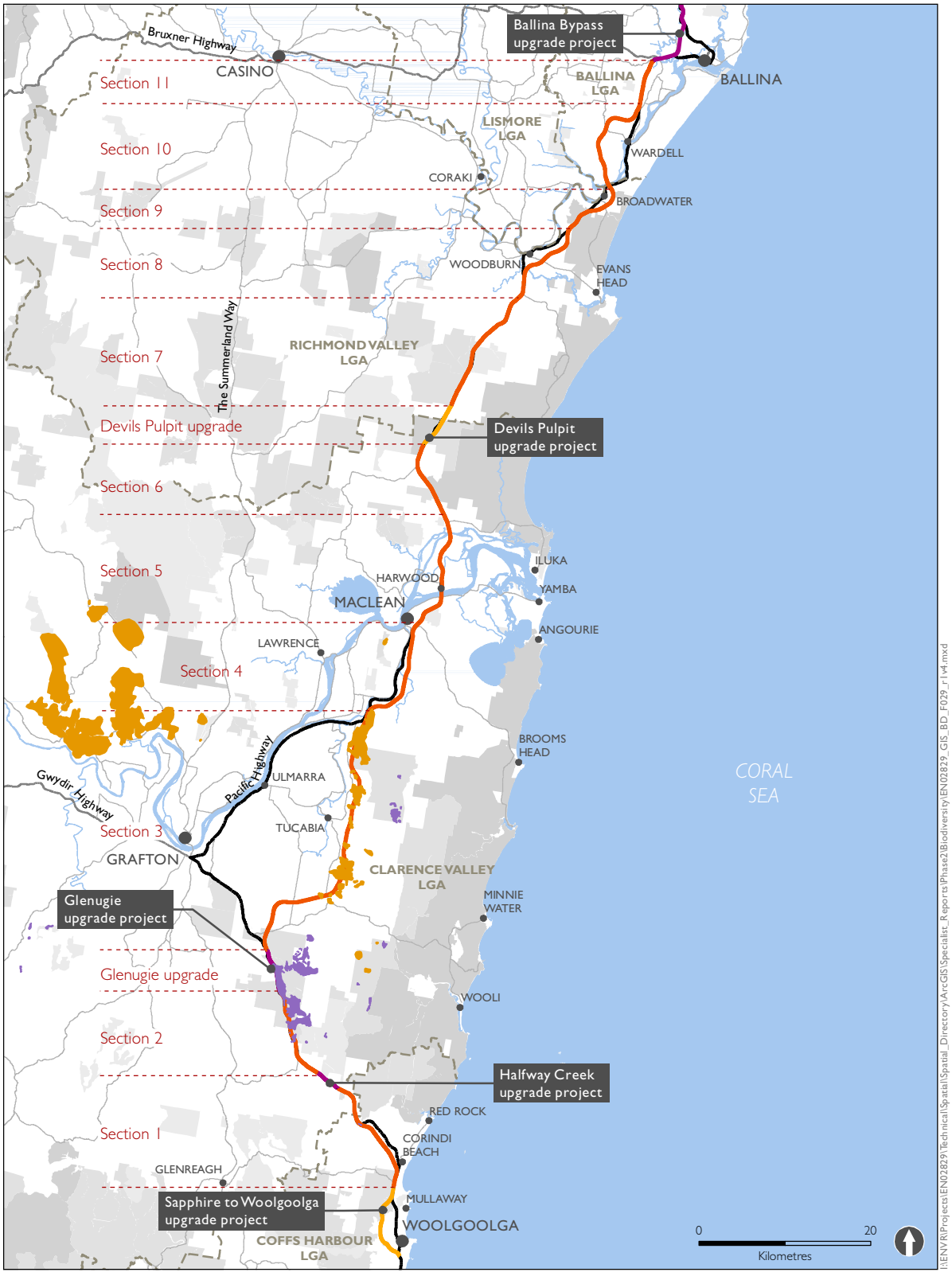
Habitat

Geologically, the regional population is restricted to within the province of the Clarence-Moreton Basin supporting sub-horizontal Jurassic and Cretaceous lithic and quartz sandstones and claystones, with extensive areas of alluvials and coastal barrier sands (Morgan 2001). *Angophora robur* is mainly restricted to the Summervale Range and the Richmond Range with a small number of records also occurring on the Clarence - Manning Basin Margin and the Grafton-Whiporie Basin. The Summervale Range and Richmond Range Mitchell landscape units occur on middle Jurassic quartz sandstone and conglomerate. The soil types of the Summervale Range landscape unit comprise shallow stony red-brown structured loams, and red, yellow or brown texture-contrast soils in different slope positions. The Richmond Range landscape unit comprises Red-brown and yellow texture-contrast soils on slopes and uniform clay loams along valleys with high organic content.

There is limited published information regarding habitat for *Angophora robur* apart from general descriptions in identification texts (Harden 2002; Brooker *et. al*. 2002) which describe the species as occurring in dry open forest in sandy or skeletal soils on sandstone, or occasionally granite, with frequent outcrops of rock. From the field surveys, it is evident that *Angophora robur* occurs on sandy soils on slopes and ridges, but was absent from the dryer ridges and upper slopes with highly skeletal soils and the more fertile lower slopes where Turpentine (*Syncarpia glomulifera*) is dominant and some gullies where swamp forest and other riparian vegetation is present. It was recorded on the fringes and within swamp forest habitats in several locations.

On more exposed ridges and upper slopes with skeletal soils *Angophora woodsiana* is dominant, with a low abundance of *Angophora robur* (c. 1/hectares), and hybrids between the two species were observed in these areas. *Angophora woodsiana* was also observed co-occurring with *Angophora robur* on lower slopes in some areas, but in a very low abundance.

Figure 3-80 Regional distribution of *Angophora robur* and *Eucalyptus tetrapleura*



Angophora robur was also absent from some areas which appeared to support suitable habitat which makes it difficult to predict the distribution and abundance of the species. Further, there has not been any detailed soil landscape mapping undertaken for the Grafton and Bare Point 1:100 000 map sheets which cover Sections 3 to 5 of the study area, making it problematic to accurately predict and map the distribution of the species.

A diversity of other tree species was recorded occurring with *Angophora robur* from the following broad vegetation associations:

- Scribbly Gum-Red Bloodwood (*Corymbia gummifera*)
- Northern Grey Ironbark-Tallowwood-Pink Bloodwood
- Needlebark (*Eucalyptus planchoniana*)-Scribbly Gum
- Tallowwood-Bastard White Mahogany (*Eucalyptus psammitica*)
- Bailey's Stringybark (*Eucalyptus baileyana*)-Blackbutt-Red Bloodwood.

Population distribution

The regional extent of the population consists of three large clusters or sub-populations, all located within 30 kilometres of Grafton. A description and estimated size of the different sub-populations is detailed in Table 3-16. Further detail of the population that would be impacted by the project is described in Chapter 4.

Table 3-16: Angophora robur population clusters in the study area

Subpopulation location	Area of habitat occupied (hectares)	Predicted population number
Eastern Population (Pillar Valley, Tucabia, Tyndale including Pine Brush SF and Newfoundland SF)	Known: 1,471.4	Known: 123,601
Population Cluster 1 – Pillar Valley	451.5	37928
Population Cluster 2 – Firth Heinz Rd	14.7	1237
Population Cluster 3 – Bostock Road	15.8	1328
Population Cluster 4 – Sommervale Road to Tallowwood Lane	189	15876
Population Cluster 5 – Tucabia Road	14.1	1183
Population Cluster 6 – Tyndale	684.2	57476

Hairy-joint Grass (*Arthraxon hispidus*)

Description

Hairy-joint Grass (*Arthraxon hispidus*) is a creeping grass with branching purplish stems. Leaf-blades are 2–6 centimetres long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. This grass is considered to be a perennial but it tends to die down in winter.

Distribution

This species is a cosmopolitan species which is relatively widespread but uncommon throughout southeast Queensland and the NSW North Coast and Northern Tablelands, as well as occurring from Japan to central Eurasia.

Habitat

Arthraxon hispidus occurs in moist, shady positions and is usually found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.

Population distribution and abundance

Several large populations of this species were recorded in Section 10 between Coolgardie Road and Lumleys Lane covering a total area of 20.8 hectares. Further details on the context of the populations in relation to the project boundary are provided in Chapter 4.

Water Nutgrass (*Cyperus aquatilis*)

Description

Water Nutgrass (*Cyperus aquatilis*) is a small sedge species to 10-30 centimetres tall with weak triangular stems. The leaves are 1-3 millimetres wide and shorter than the flowering stem. The flower and seedhead is made up of several branches radiating from the top of the stem. Each branch has one to eight flattened spikelets 3 millimetres wide. The seeds are three-sided nuts that are whitish to pale brown.

Distribution

This species is a cosmopolitan species which is relatively widespread throughout the northern states of Australia including Queensland, Western Australia and the Northern Territory, as well as occurring in Papua New Guinea.

Habitat

In the study area this species occurs in disturbed, boggy sites in floodplain open forest or pastureland. *Cyperus aquatilis* appears during the wet summer period in ephemerally wet sites then dies off in early spring as the habitat dries out. Records from the coastal floodplain are nearly all from track ruts on recently disturbed, muddy access trails (Ecos Environmental 2007). It also occurs in seepage areas from small sandstone cliffs.

Population distribution and abundance

Species is only known from a small number of records north of Grafton in NSW, mainly between the Pacific Highway in the east and Summerland Way to the west (OEH 2012c), including records in the project boundary. This species has been observed at numerous locations throughout the project boundary between 2005 and 2010.

The species was recorded at six locations in Sections 6 and 7 (Ecos Environmental 2007) in low to moderate abundance. During further surveys (January 2012), it could only be located in Mororo State Forest, where a relatively large population (c. 80 plants) was previously recorded. Similarly, locations of this species recorded in winter 2005 where found not to support the species during summer 2006, suggesting the distribution and abundance of the species is highly variable and dependant on numerous factors such as habitat disturbance, flooding events, seed dispersal and climatic conditions.

Other records in the study include a grazed paddock area south of Jacky Bulbin Road (c. 18 plants), a disturbed drainage line north of Glencoe Road (9 plants) and several locations where only 1-3 individuals were recorded including at Tabbimoble Floodway No. 2. Most of the occurrences recorded during summer 2006 were associated with boggy access tracks that had recently been disturbed by tractors or other vehicles (Ecos Environmental 2007). The population of *Cyperus aquatilis* in the study area appears to be part of a larger population extending north east into Tabbimoble Swamp Nature Reserve and Bundjalung National Park (Geolyse 2005).

Square-fruited Ironbark (*Eucalyptus tetrapleura*)

Description

Square-fruited Ironbark is a medium-sized tree growing up to 30 metres tall with a relatively straight trunk and deeply furrowed dark brown or black bark ‘ironbark’ which extends to the small branches. The bark is similar to other ironbark species occurring in the same area, particularly Broad-leaved Ironbark (*Eucalyptus fibrosa*), as they both have a flakier bark than the typically hard bark of the grey ironbarks. Adult leaves are up to 20 cm long, curved and dull green on both sides. The leaves are also typical of the species being a dull grey green and having a drooping appearance which can be used to distinguish it from other ironbark species from a distance. The four-angled buds have distinctively small caps that protrude at the end. The conical or pear-shaped fruits are quadrangular in cross-section. The fruits and buds are very distinctive and distinguish this species from other ironbark species occurring within its natural range.

Distribution

Eucalyptus tetrapleura is endemic to coastal lowlands and foothills from near Glenreagh in the south to Casino in the north, occurring within a range of around 100 kilometres north-south and 50 kilometres east-west. Within this range, the current known distribution is patchy, however the species has not been extensively surveyed and the full extent of the population is unknown.

Habitat

Eucalyptus tetrapleura occurs in dry or moist eucalypt forest on moderately fertile soil, often in low areas with poor drainage. Observations of the distribution of *Eucalyptus tetrapleura* in the region suggest that there are complex soil, topography, geology and hydrological interactions which limit the distribution of the species.

Habitat for *Eucalyptus tetrapleura* is not well defined and is not restricted to one particular vegetation association, landform, soil type or geology. Its occurrence was observed to be associated with a number of physical features influencing soil moisture and groundwater levels, including soil texture, soil depth, slope, bedrock geology and subsoil permeability. In several areas soil texture was observed to be a limiting factor to the distribution of *Eucalyptus tetrapleura*, occurring on more sandy soils overlaying clay subsoil, with *Eucalyptus fibrosa* becoming dominant in areas where the clay content of the soil is greater. In other areas, groundwater drainage appeared to be major influencing factor with *Eucalyptus tetrapleura* occurring on areas of relatively shallow soils overlying sandstone bedrock such as in Chambigne Nature Reserve and Yuraygir Crown Reserve. Overall *Eucalyptus tetrapleura* seems to occupy a niche where it is able to out-compete other Eucalypt species where soils are not too dry or wet, where drainage is not significantly impeded and in some circumstances where soils are not too shallow but shallow enough for the bedrock to influence groundwater levels.

In Glenugie and Pine Brush state forests *Eucalyptus tetrapleura* was recorded in two broad vegetation associations and occurs in all topographic situations including ridges, gullies and upper, lower and mid slope areas. *Eucalyptus tetrapleura* is mainly associated with Large-leaved Spotted Gum on ridges and slopes. It also occurs in broad depressions, gullies and riparian areas with a wide range of species. Species recorded during the study occurring with *Eucalyptus tetrapleura* include Narrow-leaved Red Gum (*Eucalyptus seeana*), Forest Red Gum, Grey Box (*Eucalyptus molucanna*), Pink Bloodwood, and Red Mahogany, Swamp Turpentine, *and Angophora woodsiana*, Small-fruited Grey Gum, Orange Gums (*Eucalyptus bancroftii*), White Mahogany (*Eucalyptus acmenoides*) and Paperbarks. In many areas, *Eucalyptus tetrapleura* is associated with a thick shrub understorey including Honeymyrtle, Black She-oak (*Allocasuarina littoralis*) and Curracabah (*Acacia concurrens*).

In Chambigne Nature Reserve, *Eucalyptus tetrapleura* occurs towards the top of the sandstone escarpment on gentle sloping benches between the rocky outcrops on top of the escarpment and the cliff areas or steeper slopes surrounding the escarpment. In this area, *Eucalyptus tetrapleura* forms a dominant component of the vegetation community particularly on the western facing side of the escarpment. Associated species in Chambigne Nature Reserve include Bailey's Stringybark, Large-fruited Blackbutt (*Eucalyptus pyrocarpa*), Red Bloodwood, Bastard Tallow-wood, Bastard White Mahogany and Sandstone Rough-barked Apple.

Within areas of Yuraygir Crown Reserve *Eucalyptus tetrapleura* was recorded in areas supporting Tallowwood, Scribbly Gum (*Eucalyptus sclerophylla*) and Stringybark (*Eucalyptus tindaliae*). These areas have sandy soils and *Eucalyptus tetrapleura* occurs in low to moderate abundances in these areas.

Although *Eucalyptus tetrapleura* does occur with other ironbark species in areas, it usually

is the dominant ironbark species where it occurs, and other ironbark species are generally limited to the edges of its preferred habitat conditions. Other ironbark species occurring with *Eucalyptus tetrapleura* recorded during the surveys include Broad-leaved Ironbark, Northern Grey Ironbark, Thin-leaved Ironbark (*Eucalyptus crebra*) and Grey Ironbark (*Eucalyptus fusiformis*).

Population distribution

The major populations for *Eucalyptus tetrapleura* were recorded in the Glenugie area which has been partially impacted by the Glenugie upgrade (refer to Figure 3-80). Large populations are predicted to be present to the east of Glenugie State Forest on private property adjoining Yuraygir State Conservation Area and Glenugie Peak Flora Reserve. *Eucalyptus tetrapleura* was recorded along areas of Rockview Road at Chambigne during the surveys and was observed to extend into areas of private property surrounding this road, and although no population assessments were carried out in this area, *Eucalyptus tetrapleura* is expected to be relatively abundant in this area. Further details on the context of the population in relation to the project boundary are provided in Chapter 4.

Slender Screw Fern (*Lindsaea incisa*)

Description

Slender Screw Fern (*Lindsaea incisa*) is a delicate-looking ground fern with a creeping underground root. The light-green fronds are slender, up to 50 cm long, and stand erect or tangled through other vegetation. Divided fan-shaped leaflets are spaced along the stems, often in pairs. The spores are produced under membranous flaps on the lobes of some of the leaflets.

Distribution

In NSW it is known only from a few locations between Woombah and just south of Coffs Harbour. It also occurs in north and south-east Queensland.

Habitat

Lindsaea incisa grows in damp sandy places in dry eucalypt forest on sandstone and moist shrubby eucalypt forest on meta-sediments. It is usually found in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly.

Subject population

In the study area, *Lindsaea incisa* was associated with the edges of drainage swales on sandy soils within and on the edges of swamp forest communities and moist sclerophyll forest. Numerous locations were within previously disturbed areas with an open canopy. Populations were recorded in or directly adjacent to the project boundary in Sections 1-3 and Section 6. Populations were found along the edges of drainage swales with sandy soils. Further details are provided in Chapter 4.

Maundia triglochinoides

Description

Maundia triglochinoides is a perennial species with creeping rhizomes that have emergent tufts of leaves arising along their length. Leaves are triangular in cross section and are up to 0.8 metres long and 5-10 millimetres wide. Inflorescences are to 10 centimetres long and 2.5 centimetres wide.

Distribution

It is restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong, with the species around Sydney considered to be extinct.

Habitat

Maundia triglochinoides grows in swamps, creeks or shallow freshwater 30-60 centimetres deep on heavy clay with low nutrients. In the study area, it was observed growing in major creeks and rivers or lagoons associated with these such as Halfway Creek, Wells Crossing, Coldstream River and Chaffin Creek. It was also associated with smaller drainage lines and areas of swamp forest at several locations. Several of the locations appeared to have sandy soils rather than heavy clay.

Population distribution

Maundia triglochinoides was recorded at 15 locations during field surveys in 2011 and 2012, of which 12 are within the project boundary. Further details are provided in Chapter 4.

Weeping Paperbark (*Melaleuca irbyana*)

Description

Weeping Paperbark (*Melaleuca irbyana*) has thick, spongy, papery bark and grows to about eight metres tall. It has a dense, rounded canopy of very fine, weeping foliage. The tiny, stalkless, pointed leaves are less than four millimetres long, smaller than any other Melaleuca species growing in the local area. The leaves are appressed close to the branchlets, wrapping around them slightly. In summer profuse white flowers, arranged in groups of three, are present and are followed by tight clusters of woody fruits.

Distribution

In north-east NSW it is found in several locations including near Coraki, Casino and Coutts Crossing south of Grafton. Also occurs in near Ipswich south-east Queensland.

Melaleuca irbyana was recorded at several locations surrounding the project boundary in Section 3 and a large population is present within the project boundary at New Italy. Large populations have also been recorded at Glenugie west and east of Pacific Highway (RTA 2009).

Habitat

Melaleuca irbyana occurs in open eucalypt forest on poorly drained clay soils. Populations within and surrounding the project boundary were observed in ecotonal areas between Spotted Gum – Ironbark and swamp forest/floodplain forest communities. Populations observed in and surrounding the project boundary co-occurs with Prickly-leaved Paperbark (*Melaleuca nodosa*).

Population distribution and abundance

The only population known to occur in the project boundary is at New Italy and is currently bisected by the existing Pacific Highway with individuals occurring on both sides of the highway. The population extends into private property to the west of the project boundary occurring in modified habitats including semi-mature forest and unmaintained areas. The New Italy population contains around 800 individuals, spread over around 1.5 hectares with around 400 individuals (Ecos Environmental 2007).

Threatened flora outside the project boundary

An additional nine threatened flora species were identified from the targeted surveys outside of the project boundary as part of the route options phase; these are shown in Table 3-17 as they are considered as potential subject species.

Table 3-17: Threatened flora recorded outside of the project boundary

Scientific Name	Common Name	Status		Confirmed
		TSC Act	EPBC Act	
Desmodium acanthocladum	Thorny Pea	V	V	Section 8
Endiandra hayesii	Rusty Rose walnut	V	V	Section 10
Oberonia titania	Red-flowered King of the Fairies	V	-	Section 7 and 10
Isoglossa eranthemoides	Isoglossa	E	E	Section 10
Marsdenia longiloba	Slender Marsdenia	E	V	Section 10
Prostanthera palustris	Swamp Mint Bush	V	V	Section 7
Quassia sp. 'Moonee Creek'	Moonee Quassia	E	E	Section 3
Syzygium hodgkinsoniae	Red Lilly Pilly	V	V	Section 10
Tinospora tinosporoides	Arrow-head Vine	V	V	Section 10

E = Endangered species; V = Vulnerable species

3.9.4. Threatened fauna

A total of 42 threatened fauna species were identified in the study area from the targeted field surveys project, details on the species and the knowledge collated on population size and distribution where possible is presented in Table 3-18 and mapped in Figure 3-34 to Figure 3-43. This list includes three species listed as endangered under the EPBC Act, six endangered species listed under the TSC Act, one endangered population (TSC Act), two national vulnerable species (EPBC Act) and 35 species listed as vulnerable under the TSC Act.

Table 3-18: Threatened fauna species confirmed in the project boundary

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Mixophyes iteratus	Giant Barred Frog	E	E	This species was only recorded at Corindi River (Section 1), where seven individuals were observed during the summer survey period (2007). Typically found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest, and wet sclerophyll forests and swamp sclerophyll forest (OEH 2012d; Ehmann 1997). This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997). Suitable habitat for the giant barred frog occurs at other major freshwater creeks in Section 1-2, particularly Dirty Creek and Halfway Creek. In most cases the remainder of the study area provides limited habitat for the Giant Barred Frog largely because it requires permanent creeks with specific habitat attributes including pool-riffle sequences, steep sided banks and adequate riparian vegetation often comprising moist sclerophyll or lowland riparian rainforest species (Lewis and Rohweder 2005).	Section 1 and 7
Botaurus poiciloptilus	Australasian Bittern	E	E	A single individual was recorded near Champions Creek in Section 3, just north of Tyndale. The species is cryptic and difficult to detect. It is likely that a population occurs across the Clarence River floodplain wetlands and has been historically known from this area (Smith 2011)	Section 3
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Grey-headed Flying-fox was detected at five of the eight survey sites in Sections 1 and 2 and commonly recorded in Section 3-5, 6-8 and 9-11. No roost camps have been identified within the actual project boundary, however there are several known colonies in the region including Woolgoolga (Section 1), a camp at Maclean and Farlows Swamp within 2 kilometres of the boundary (Section 4-5) one at Woodburn (Section 8) and Wardell (Section 10). Forested habitats within the project boundary would be frequented by individuals within these colonies and may constitute important habitat during pre- and post-breeding life-cycle events.	Sections 1-11
Phascolarctos cinereus	Koala	V	V	Koalas are known to occur throughout the region and near the project boundary with potentially important populations in the vicinity of Broadwater National Park; Riley's Hill and in the sclerophyll forests of the Wardell heaths (Sections 7-10). Road deaths for Koalas have occurred in Section 1 and 2, and as such they are considered likely to occur throughout suitable habitat. Koalas were recorded at two sites during surveys in Section 3.	Section 3

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Burhinus grallarius	Bush stone-curlew	E		Recorded in Sections 1-2 from a call playback survey, the exact location not reported. The species is uncommon in northern NSW and restricted to open woodland habitats, typically spotted gum –ironbark habitat with a sparse understorey as is found in parts of Section 1-2 and the southern end of Section 3 around the northern end of Glenugie State Forest and Eight Mile Lane.	Section 2
Ephippiorhynchus asiaticus	Black-necked Stork	E		Numerous records for Black-necked Stork exist in the Section 1 and 2 study areas, particularly at Halfway Creek and the Corindi River floodplain. The species is also relatively common throughout Sections 3 to 5 on the Clarence River wetlands (Clancy 2010).	Sections 1-5
Dromaius novaehollandiae	Coastal Emu Population	E2		A portion of the endangered coastal emu population uses habitat in Sections 3 and 4 which includes important habitat used in pre- and post-breeding life-cycle activities associated with wetland and floodplain habitat from Pillar Valley to north of Tucabia and the Shark Creek area.	Section 3-4
Anseranas semipalmata	Magpie Goose	V		A pair of Magpie Geese was recorded near the lower Coldstream River in a crown reserve (Travelling Stock Route) on Wants Lane (Section 3). The species was once common in the Clarence River floodplain (Smith 2011) although are only occasional visitors to the north coast region now, being more common across northern Australia.	Section 3
Calyptorhynchus lathami	Glossy-black Cockatoo	V		There are several records for the Glossy Black-cockatoo around Halfway Creek and further south in Section 1. A pair was recorded in Section 3 near McRae Knob to the northeast of Tyndale adjoining and contiguous with Pine Brush State Forest. This area supports an abundance of Allocasuarina and large tree hollows along the foothills of the Summervale Range. Glossy Black-cockatoos were also recorded in Section 7 just south of Serendipity Road at Tabbimoble and in suitable habitat near Wardell Road in Section 10. Preferred habitat for this species is widespread and populations of Glossy Black-cockatoos are considered likely to occur throughout the study area.	Section 1, 3, 7 and 10
Climacteris picumnus	Brown Treecreeper	V		Brown Treecreepers were detected in drier open woodland habitats near Wells Crossing at the northern end of Section 2, particularly around Bald Knob Tick Gate Road at the southern end of Glenugie State Forest in drier open woodland habitats. Reported throughout Glenugie State Forest north to Six Mile Lane may encompass the southern end of Section 3. Also recorded in the drier habitats of Devils Pulpit State Forest and north into Tabbimoble (Section 6 and southern end of Section 7). Habitats north of here are too moist, dense or closed for this species to occur.	Section 2, 6 and 7

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Grus rubicundus	Brolga	V		Brolga are commonly recorded but patchily distributed across the study area, in particular the Clarence River wetlands (Smith 2011) and have been observed near the project boundary in Section 1 on the Corindi River floodplain, and Section 2 near Halfway Creek, and Section 3, at Ellis Swamp near Sandy Crossing. Potential habitat is widespread and the species prefers low-lying floodplain habitats, therefore may also occur in Section 7 and 9-11.	Section 1-3
Lichenostomus fasciogulari	Mangrove Honeyeater	V		Mangrove Honeyeaters were recorded during surveys in Section 10. In NSW most observations of Mangrove Honeyeater occur south to the Clarence River, around Tweed Heads, near Broken Head, and in the estuary of the Clarence River, near Iluka and Yamba (Section 4 and 5)	Section 10
Melithreptus gularis gularis	Black-chinned Honeyeater (estn ssp.)	V		The species was detected in drier open woodland habitats near Wells Crossing, and is considered likely to occur in suitable habitats throughout the Section 1 and 2 and the southern end of Section 3. A population was located in the south of Section 3. It is also expected to occur in other suitable habitat throughout Sections 2 and 3. It is unlikely further north of this area.	Section 2
Ninox strenua	Powerful Owl	V		Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding. Powerful Owls were recorded in Section 3 in dry forest on sandy soils near Pillar Valley Creek, also Section 7 at 1.5 kilometres south of New Italy in the larger forests associated with Devils Pulpit and Doubleduke state forests and Section 9 where calls were heard at a large distance (emanating from Blackwall Range), to the west of the study area. This latter record was not confirmed due to the distance and hence low volume of the call at the observation location. The species could occur in all sections although have a restricted distribution associated with dense forests and wetter riparian areas.	Section 3, 7
Pandion haliaetus	Eastern Osprey	V		Ospreys were reported in floodplain and estuarine habitats throughout all sections. There are no reported nests in the project boundary at the time of this assessment; however this would need to be assessed prior to detailed design and construction. Important habitat occurs within the Clarence and Richmond River floodplains (Clancy 1991) and an artificial nest pole has been erected on the western side of the Harwood Bridge outside of the project boundary.	Section 1-11

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Pomatostomus temporalis temporalis	Grey-crowned Babbler (estn ssp.)	V		The species was consistently detected during surveys through Section 3 and Sections 6-8. It was also detected in drier open woodland habitats near Wells Crossing (Section 2) and is considered likely to occur in suitable habitats throughout Sections 1 and 2 and Section 3. Grey-crowned Babblers are known to breed in habitat near Thurgates Lane (Section 10). Other nesting sites and breeding habitat has not been confirmed.	Section 3, 6, 7 and 8
Ptilinopus regina	Rose-crowned Fruit Dove	V		Rose-crowned Fruit-dove was detected in Sections 10. There are numerous records for the species in the north of the study area including Thurgates Lane and Coolgardie Scrub, with potential habitat also in the vicinity of Lumley's Lane in Section 10	Section 10
Tyto capensis	Eastern Grass Owl	V		Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey & Knight 1997). The species was observed circling over a survey site at Broadwater South (Section 9). The species could occur throughout the study area and particularly low-lying floodplain habitats including Corindi River (Section 1) Clarence Valley wetlands (Section 3-5), Tabbimobile (Section 7) and Broadwater to Ballina (Section 9-11).	Section 9
Tyto novaehollandiae	Masked Owl	V		Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland and especially the ecotone between wet and dry forest, and non forest habitat. A Masked Owl was recorded from call playback surveys in Section 11, but was not visually identified. The species may occur throughout the entire study area particularly in larger open dry forest habitats in Section 1-3 and 6-10.	Section 11
Tyto tenebricosa	Sooty Owl	V		The sooty owl was only recorded at one location in Newfoundland State Forest (Section 2). A single bird was observed after it responded to the call playback. This species is likely to occur along the major creeks where rainforest or moist eucalypt forest occur as riparian habitat, most likely areas being Corindi River and possibly parts of Halfway Creek and Dirty Creek, within the Dirty Creek Range (Section 1-2). The remainder of the study area was considered marginal for this species.	Section 2

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Chalinolobus nigrogriseus	Hoary Wattled Bat	V		The preferred habitat of this species appears to be variable, with dry open forest, woodland, vine thickets, coastal scrub, sand dunes, grasslands and floodplains recorded (Churchill 1998). This species often forages along watercourses, swampy areas and over farm dams. In NSW (NPWS 2012b), this species has been recorded in Spotted Gum (*Corymbia maculata*), Grey Box (*Eucalyptus moluccana*) and Northern Ironbark (E. siderophloia) and woodland characterised by Scribbly Gums (*E. signata*) and Pink Bloodwood (*C. intermedia*) and sites dominated by the Blackbutt (*E.pilularis*). Hoary Wattled Bats were recorded from call analysis in Sections 1-3 and Sections 6-8. Suitable habitat also occurs in Section 4-5, and 9-11.	Section 1-3 and 6-8
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		Calls for Eastern False Pipistrelle were recorded in Section 1, 2 and 3 They are expected to occur in suitable habitats throughout the entire study area in particular dry sclerophyll forest on sandy or clay soils through section 1-9.	Section 1-3
Miniopterus australis	Little Bent-wing Bat	V		Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelter in a range of structures including culverts, drains, mines and caves. Relatively large areas of dense vegetation of wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found. Breeding occurs in caves. Little Bent-wing Bat were captured and recorded in all sections and appear to be relatively common Locations of roost sites were not identified.	Section 1-11
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V		Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). Would use caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Dwyer 1995). Calls for Eastern Bent-wing Bat, were recorded in Section 1-2, 6-8 and 9-11. They are expected to occur in suitable habitats throughout the entire study area (Section 1-11).	Section 1-2 and 6-11
Mormopterus norfolkensis	Eastern Freetail-Bat	V		Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts. Eastern Freetail-bat was recorded in Sections 6-8 and 9-11. They are expected to occur in suitable habitats throughout the entire study area (Sections 1-11).	Section 6-11

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Myotis macropus	Southern Myotis	V		Would occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, as long as they are close to water (Churchill 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains (Churchill 1998). However the species has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998). Southern Myotis were recorded in Sections 1-2 and 6-8 and 9-11 from positive call identification. This species could occur along the entire study area.	Section 1-2 and 6-11
Nyctophilus bifax	Eastern Long-eared Bat	V		This species prefers wetter habitats, ranging from rainforest and monsoon forest to riverine forests of paperbark, but may be found in open woodland, tall open forest and dry sclerophyll woodland (Churchill 1998).These forest bats have been recorded roosting under peeling bark, among epiphytes, in tree hollows and in foliage (Churchill 1998). Individuals are likely to change roost sites nightly (OEH 2012f). Eastern Long-eared Bats were recorded in Sections 6 -8 and 9-11. They are expected to occur in suitable habitats throughout the entire study area.	Section 6-11
Syconycteris australis	Common Blossom-bat	V		The combination of heathland and coastal rainforest is essential for this species (Churchill 1998). Breeding and sheltering habitats are in subtropical and littoral rainforests and a diverse range of nectar producing plant communities are required year round; it would occasionally eat some rainforest fruits (Churchill 1998. There is known roosting and foraging habitat for Common Blossom-bat in the sections 8-11	Section 8-11
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V		Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies (SFNSW 1995). Roosts in tree hollows; may also use caves. The Yellow-bellied Sheathtail-Bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats. Identified from call analysis in Sections 9-11 and expected across the entire study area.	Section 9-11
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1995). Recorded in Section 9-11, and expected to occur across the entire study area.	Section 9-11

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Kerivoula papuensis	Golden-tipped Bat	V		The most favoured habitat for this species is moist closed forests often with a rainforest influence; however, some captures have been made in dry forests some distance from any rainforest (Lunney & Barker 1986; Parnaby & Mills 1994). It has been suggested that the amount of vines and complex tree layers allows for increased numbers of spiders and webs and such areas are sought by the Golden-tipped Bat (Schulz & Eyre 2000). This species is often caught over streams within rainforest are known to frequently roost within the pendulous nests of Yellow-throated and Large-billed Scrub Wrens and Brown Gerygone in such areas (Schulz & Eyre 2000). The species was recorded in Sections 9-11 and suitable habitat also occurs in Section 1-2 and 6-8.	Section 9-11
Vespadelus troughtoni	Eastern Cave Bat	V		Inhabits tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas (Churchill 1998). Has been found roosting in sandstone overhang caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998). Eastern Cave Bats were recorded in Section 6 to 8 and 9-11 and could occur across the entire study area.	Section 6-11
Aepyprymnus rufescens	Rufous Bettong	V		Prefer forests with a grassy to sparse understorey including coastal forest, tall wet sclerophyll forest and dry forests west of the Great Diving Range (OEH 2012g). It is most commonly found on sites derived from sedimentary rock and in north eastern NSW in forests characterised by Spotted Gum (*Corymbia maculata* and *C. henryi*) (OEH 2012g). Rufous Bettong was recorded in Sections 1-3 and predicted to occur in Section 6-8. Numerous records exist in dry open forest and woodlands north of the Halfway Creek Service Centre, and numerous road kills on Six Mile Lane and Airport Road have been reported (Sections 1 and 2 and the southern end of Section 3). Records for this population in the southern end of the project extend up to Section 3 in the Pheasants Creek and upper Coldstream localities and Sections 1-3 is considered a hotspot for this species.	Section 1-3
Petaurus australis	Yellow-bellied Glider	V		This species is restricted to tall mature forests, preferring productive tall open sclerophyll forests with a mosaic of tree species including some that flower in winter (Braithwaite 1984, Davey 1984, Kavanagh 1984; NPWS 1999b). Large hollows within mature trees are required for shelter, nesting and breeding (Henry & Craig 1984; NPWS 1999b). Yellow-bellied Glider was recorded in Sections 1-3 and 6-8. There are several records for the species in the Halfway Creek area (Section 2) which is considered a hotspot for this species. The species is expected to be widespread.	Section 2

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Petaurus norfolcensis	Squirrel Glider	V		Associated with dry hardwood forest and woodlands (Menkhorst et al.1988). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995). Squirrel Gliders were widespread throughout the study area, being recorded in all Sections 1-11. Most records of the species occur around Halfway Creek (Section 2), Pillar Valley to Tyndale (Section 3), and Mororo to Broadwater (Section 6-8).	Section 1-11
Phascogale tapoatafa	Brush-tailed Phascogale	V		Preferred habitat is dry open forest with a sparse open understorey, however, has been located in heath, swamps and rainforest and wet sclerophyll forest (NPWS 1999l). Suitable habitat for Brush-tailed Phascogale was identified north from Halfway Creek to Wells Crossing (Section 1-4) and the species was confirmed in Section 2 and 4 and 6-8.	Section 2, 4, 6,7,and 8
Planigale maculata	Common Planigale	V		Found in subtropical to dry rainforest, dry sclerophyll forest, heathland and grassland up to 400 m elevation (OEH 2012h; Strahan 1998). Habitat selection is dependent on surface cover (OEH 2012h). The species was recorded during surveys in Section 1 and 2, and is considered likely to occur in suitable habitats throughout these areas as well as part of Section 3 and 6-8. The species is known to breed in Wardell heath and adjoining areas through section 8-10.	Section 1-2
Crinia tinnula	Wallum Froglet	V		Found in wallum swamps and associated low land meandering watercourses on coastal plains (Ehmann 1997). Occurs in elevations up to around 50 m and is closely related to freshwater habitats in the coastal zone (OEH 2012i). Found most commonly in wallum wetlands characterised by low nutrients, highly acidic, tannin-stained waters that are typically dominated by paperbarks and teatrees. Also found in sedgeland and wet heathland (OEH 2012i) Wallum Froglet was detected in Sections 1-3 from Woolgoolga north to Pheasants Creek, also 6-8 and 9-11.	Section 1,2 and 6-11
Litoria brevipalmata	Green-thighed Frog	V		Found in wet sclerophyll forest along the northern coast of NSW to Ourimbah (Anstis 2002). Also in a variety of habitats including dry to wet sclerophyll forest, rainforests and shrubland with a healthy understorey (OEH 2012j). Breeding aggregations occur in still water habitats. Green-thighed Frogs were detected during surveys in Sections 1 and 6 to 8. The species could occur in all sections.	Section 1 and 6-8

Scientific name	Common name	Status		Identified records and project section	Confirmed
		TSC Act	EPBC Act		
Hoplocephalus stephensii	Stephen's' banded snake	V		Found in a variety of habitats from rainforest through wet and moist sclerophyll forests to dry sclerophyll forests (OEH 2012k). Most commonly found in wet to moist forests with rocky outcrops, cliffs or ridges and tends to favour ecotones between wet and dry forests (OEH 2012k). Frequently uses gaps in the peeling bark of large senescent or dead trees for daytime shelter. However it can use hollow trunks, limbs, epiphytes, vine thickets, rock crevices or rock slabs (OEH 2012k). This species was recorded from surveys in Sections 3 and could occur throughout all sections.	Section 3
Phyllodes imperialis southern subsp.	Pink Underwing Moth	E	E	The Pink Underwing Moth was recorded at the northern end of project in section 10 in a rainforest / moist forest remnant within and adjacent to the project boundary. This observation consisted of several Pink Underwing Moth larvae at two sites (refer Appendix L for specialist report). The potential habitat for this species includes lowland rainforest and low elevation moist floodplain forest with high species diversity. These habitat types were found in the northern end of the project (Section 10 and 11). Potential breeding habitat is restricted to areas where the caterpillar's food plant, a native rainforest vine, *Carronia multisepalea.*	Section 10
Nurus atlas	Atlas Rainforest Ground Beetle	E		The species was recorded at the northern end of project in section 10 with a rainforest remnant located within and adjacent to the project boundary. This observation comprised a single adult Atlas Rainforest Ground Beetle encountered in a burrow positioned under a large protruding root of a White Cedar (Melia azedarach) in soil derived from basalt. The potential habitat for this species includes lowland rainforest in the northern end of the project (Section 10 and 11). The records in the study area represent the first records for the region around Ballina. There is only one previous record of the ground beetle between Alstonville and Coraki.	Section 10

E = Endangered species; E2 = Endangered population (TSC Act); V = Vulnerable species

An additional four threatened fauna species were identified in areas outside the project boundary including:

- Olongburra Frog (*Litoria olongburensis*), an endangered species (EPBC Act). Found in wallum, woodlands and sedgelands on coastal swamps dominated by *Melaleuca quinquenervia* with an understorey of the sedge *Lepironia articulata* are typical habitat (OEH 2012). Suitable wallum swamps are characterised by low nutrients, highly acidic, tannin-stained waters occurring on Pleistocene coastal sand deposits (OEH 2012). Tentative identification in section 11 and the species could also occur in Sections 6 to 11
- Long-Nosed Potoroo (*Potorous tridactylus tridactylus),* vulnerable species (EPBC Act) and (TSC Act). Not positively identified in the study area, although hair samples collected in Section10 (Geolyse 2007). There are numerous records for this species in the Wardell Heath to the east of the project boundary in Section 10
- Pied Oystercatcher (*Haematopus longirostris),* an endangered species (TSC Act). Pied Oystercatcher was observed in adjacent coastal areas outside the project boundary during surveys in Sections 1, 2, 9 to11. They are known to occur in coastal habitats adjacent to the study area, but are unlikely to be critically dependent on wetland and riverine habitats within the project boundary
- Black Flying-fox (*Pteropus alecto*), previously listed as a vulnerable species (TSC Act), this species has now been removed from the NSW threatened species list. Mangroves, paperbark forests and occasionally patches of rainforest are most commonly used for camp sites (Strahan 1998; Churchill 1998). They have been found to occupy a range of habitats of tropical and subtropical forests and woodlands (Churchill 1998). Recorded near section 1 to the south of the project, associated with a roost camp of Grey-headed Flying-fox at Woolgoolga and also outside the boundary in sections 9 to 11.

Bridge inspections for threatened roosting bats

No roosting bats or bat guano was recorded from the Duck Creek or Emigrant Creek bridge inspection. Both bridges are of concrete and steel construction and provide limited roosting habitat for bats. All accessible potential roosting sites were inspected with a hand-held torch and a bat detector (Anabat II). This included joins between pylons and bridge deck, drainage scuppers and enclosed spaces between steel beams.

In general, the steel structure and neat concrete finish provides limited roosting opportunities for insectivorous bats. The Emigrant Creek bridge contains higher potential habitat than the Duck Creek bridge. Drainage scuppers could be used as short-term (temporary) roosts.

3.9.5. Migratory species

A total of ten listed migratory species (EPBC Act) were identified from the project surveys within the study area (Table 3-19) and an additional two species are also considered to have a high likelihood of occurring. The location of migratory species is discussed below.

Table 3-19: Migratory fauna species (EPBC Act) recorded and expected in the study area

Migratory species	EPBC Act status	Preferred habitat	Survey results and potential habitat
Osprey (*Pandion haliaetus*)	Marine; Migratory (BONN)	Occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers	Identified in several locations associated with project sections 1-6 and 9-11. Potential to occur across the entire study area.
Great Egret (*Egretta alba*)	Marine; Migratory (CAMBA, JAMBA)	Prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	Identified in project section 8. High likelihood that the species occurs across the entire study area. This species is commonly reported in the Clarence Valley wetlands (Smith 2011) which is traversed by Section 3-5.
Cattle Egret (*Ardea ibis*)	Marine; Migratory (CAMBA, JAMBA)	Is found in grasslands, woodlands and wetlands particularly in coastal areas. It also uses pastures and croplands, especially where drainage is poor. Is often seen with cattle and other stock.	Commonly recorded in all project sections 1-5 and 9-11 associated with grazing paddocks particularly in floodplains. Likely to occur across the entire study area and commonly reported in the Clarence valley wetlands (Smith 2011) which is traversed by sections 3-5.
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Marine; Migratory (CAMBA)	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Higgins 1999; Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1999).	Reported in project section 1 near Corindi River. May occur along the length of the study area mostly in floodplain, wetland, riverine or estuarine habitats associated with the Clarence River and Richmond River.
Satin Flycatcher (*Myiagra cyanoleuca*)	Marine; Migratory (BONN)	Associated with drier eucalypt forests, absent from rainforests (Blakers et al. 1984), open forests, often at height (Simpson & Day 1999).	Was recorded in a number of sites in project sections 1-2 and 6-8 in the densely forested regions. May occur throughout the study area in all forested habitats.

Migratory species	EPBC Act status	Preferred habitat	Survey results and potential habitat
White Throated Needletail (*Hirundapus caudacutus*)	Marine; Migratory(CAMBA, JAMBA, ROKAMBA)	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Higgins 1999; Simpson & Day 1999). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Higgins 1999).	Small flock identified near Shark Creek in project section 4. This species may occur throughout the study area in all forested habitats.
Rainbow Bee-eater (*Merops ornatus*)	Marine; Migratory (JAMBA)	Occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999). Usually occurs in open, cleared or lightly-timbered areas, especially in arid or semi-arid areas, in riparian, floodplain or wetland vegetation assemblages (Woinarski et al. 1988).	Recorded near Tucabia in project section 3. This species may occur throughout the study area in all dry forest and woodland habitats, typically prefers more open landscapes.
Swift Parrot (*Lathamus discolor*)	Marine; Migratory; Endangered	Forages in swamp and open eucalypt forests, feeding on nectar and pollen of flowering tree species.	May occur throughout the study area in all forested habitats. Not observed from targeted surveys.
Regent Honeyeater (*Xanthomyza phrygia*)	Migratory (JAMBA); Endangered (as *Anthochaera phrygia*)	Forages in swamp and open eucalypt forests, feeding on nectar and pollen of flowering tree species.	May occur throughout the study area in all forested habitats. Not observed from targeted surveys.
Black-faced Monarch (*Monarcha melanopsis*)	Marine; Migratory (BONN)	Occurs in rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	Recorded in dry forest habitat at one site near Tucabia in project section 4. May occur throughout the study area in all forested habitats.
Rufous Fantail (*Rhipidura rufifrons*)	Marine; Migratory (BONN)	Frequents wet forests, less often open forests and woodlands (Simpson & Day 1999). May occur in open woodland and forest habitats throughout the north coast region.	One individual recorded in project section 6 in Doubleduke State Forest. May occur throughout the study area in all forested habitats.
Lathams Snipe (*Gallinago hardwickii*)	Marine; Migratory(CAMBA, JAMBA, ROKAMBA)	Occurs in permanent and ephemeral wetlands, usually inhabiting open, freshwater wetlands with low, dense vegetation (eg swamps, flooded grasslands or heathlands, around bogs and other water bodies) (Frith et. al. 1977). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (Frith et al. 1977)	One individual recorded in project section 3 in the Coldstream wetlands. May occur throughout the study area particularly in floodplain areas of the Richmond River, Clarence River and Corindi River.

Migratory species	EPBC Act status	Preferred habitat	Survey results and potential habitat
Australian Painted Snipe (*Rostratula australis*)	Marine; Migratory (CAMBA)	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage treatment plants and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (Melaleuca).	May occur throughout the study area particularly in floodplain areas of the Richmond River, Clarence River and Corindi River. Not observed during targeted field surveys.
Spectacled Monarch (*Monarcha trivirgatus*)	Marine; Migratory (BONN)	Occurs in rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	May occur throughout the study area in all forested habitats. Not observed during the targeted field surveys.

BONN – BONN Convention on the conservation migratory birds; CAMBA – China-Australia Migratory Bird Agreement; JAMBA – Japan-Australia Migratory Bird Agreement; ROKAMBA – Republic of Korea-Australia Migratory Bird Agreement;

3.9.6. Threatened fish

The presence of the endangered species Oxleyan Pygmy Perch (*Nannoperca oxleyana*) (EPBC Act and FM Act) was confirmed in a number of locations in Sections 7, 8 and 9 (Figure 3-81) including:

- Tabbimoble Creek (Hyder 2009) (Devils Pulpit upgrade)
- Unnamed watercourse at station 114.000 (Section 7)
- McDonalds Creek (Section 8)
- Unnamed watercourse at station 134.700 (Section 8)
- Swamps in Broadwater National Park (Biosis 2007) (Section 9).

The species is considered to occur on the basis of potential habitat identified in Section 1 and 2 associated with Redbank Creek and Casson Creek, also Section 3 in waterways of Coldstream River and Pillar Valley Creek and Black Snake Creek. Section 6 has potential aquatic habitats around Tabbimoble and Mororo Creek. Oaky Creek, Nortons Gully, Tuckombil Canal, Rocky Mouth Creek and many unnamed ephemeral streams represent potential habitat in Section 7 and 8. Aquatic environments of Section 9 and 10 also contain potential habitat in Montis Gully, Eversons Creek, Tuckean swamps and the Richmond River.

Potential habitat was identified on the basis of the habitat assessment and also crossed referenced with the work done by DPI (2010) which identified critical habitat areas in reserves. Waterways connected to these critical habitats were identified as potential habitat (refer Figure 3-81). Details on known and potential habitat for threatened fish are described below.

Table 3-20: Summary of potential habitat for threatened fish species in the study area

Project section	Notes on threatened fish species and habitat	Species	Potential habitat
1	Field surveys did not record any threatened species listed under the *Fisheries Management Act 1994* (FM Act). However, potential habitat for the endangered fish species Oxleyan Pygmy Perch (*Nannoperca oxleyana*) was identified in the Corindi River, Cassons Creek and Redbank Creek and on this basis the species is presumed to occur in these waterways. No potential habitat for the Eastern (Freshwater) Cod (*Maccullochella ikei*) was identified in these waterways.	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act)	Arrawarra Gully, Corindi River (including floodplain), Cassons Creek, Redbank Creek, Halfway Creek
2	There are no known threatened or endangered fish species in the area. There is the potential for the Oxleyan Pygmy Perch to occur in streams in this section. Database searches did not find any SEPP14 or Ramsar wetlands.	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act).	Halfway Creek Glenugie Creek Wells Crossing Unnamed and unmapped waterbodies

Project section	Notes on threatened fish species and habitat	Species	Potential habitat
3	Two freshwater species are known to occur in the general region of Section 3 - Oxleyan Pygmy Perch and Eastern (Freshwater) Cod. The low lying swamps and wallum creeks along the Coldstream River (south of Tucabia) constitute a potential habitat for the Oxleyan Pygmy Perch. The Eastern (Freshwater) Cod is likely to inhabit clear flowing streams with rocky beds, deep holes and where there is abundant snags and riparian vegetation. While there are no historical records of this species in the immediate vicinity of the study area, the mid-section of Coldstream River, Chaffin Creek and Pillar Valley Creek support suitable habitat. The Olive Perchlet (*Ambassis agassizii*) and the Freshwater Catfish (*Tandanus tandanus*) were recorded in the Coldstream River.	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act) Eastern (Freshwater) Cod (Endangered FM Act and EPBC Act) Olive Perchlet (conservation significant) Freshwater Catfish	Coldstream River Chaffin Creek Pillar Valley Creek
4	Due to the more estuarine conditions and marine influences on waterways in Section 4 there is low potential for Black Cod (*Epinephelus daemelii*) and Green Sawfish (*Pristis zijsron*) to be present as they are known to occur in the general region. These species are protected under NSW legislation.	Black Cod (Vulnerable FM Act and EPBC Act) Green Sawfish (Presumed extinct FM Act and Vulnerable EPBC Act)	SEPP 14 wetland No. 232 Shark Creek Edwards Creek Clarence River South Arm
5	Green Sawfish are a species presumed to be extinct in NSW however they have been known to occur in the North Arm of the Clarence Estuary and have a low potential to occur. Olive Perchlet (listed as endangered under the FM Act) has been recorded in the Clarence River. The Eastern (Freshwater) Cod, also protected under the FM Act, was previously known to occur in the major tributaries of the Clarence River. Hyder (2008) suggested that the southern distribution limit of the east coast population of the Purple spotted Gudgeon (listed as endangered under the FM Act) occurs around the Clarence River.	Olive Perchlet (conservation significant) Green Sawfish (Presumed extinct FM Act and Vulnerable EPBC Act) Eastern (Freshwater) Cod (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act)	SEPP 14 wetlands No. 220a and 153c Clarence River North Arm

Project section	Notes on threatened fish species and habitat	Species	Potential habitat
6	The Oxleyan Pygmy Perch is known to occur near the study area and was recorded in the Devils Pulpit Project (between Section 6 and 7) by Hyder in December 2009 at Tabbimoble Floodway 2 and downstream of the Tabbimoble Floodway 2 and 3 confluences. At both sites three individuals were recorded. Therefore Tabbimoble Floodway 2 and 3 located within Section 6 represent refugia and possible breeding sites for these species. The Ornate Rainbowfish (*Rhadinocentrus ornatus*) was also recorded in the study area. This species is classified as 'potentially threatened' by the Queensland Department of Primary Industries, however is not listed as a threatened species under NSW or Commonwealth legislation.	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act) Ornate Rainbowfish	SEPP 14 wetland No. 153 SEPP 14 wetland No. 153,153a Mororo Creek Streams within Bundajalung National Park and Devils Pulpit State Forest
7	There are no major rivers or creeks in this section, but there are several ephemeral streams. These ephemeral streams may not exhibit typical habitat characteristics for Oxleyan Pygmy Perch but they may provide important linkages to key habitats. As a precaution, some of these are likely to represent potential habitat and known records of Oxleyan Pygmy Perch were found in an unnamed creek (Class 1) in Tabbimoble State Forest (chainage 114000).	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act)	SEPP 14 wetland No. 161 Tabbimoble Floodway no.1 Tabbimoble Swamp Nature Reserve Nortons Gully Oaky Creek Unnamed and unmapped waterbodies
8	The DPI has found the Oxleyan Pygmy Perch in numerous swamps and ponds that occur in a linear belt within Broadwater National Park (Ecosense Consulting, 2008). The species has also been confirmed in and around McDonalds Creek, which drains the western-most line of the Broadwater National Park (Ecosense Consulting, 2008). While there are no recordings in the study area, there is potential for the Eastern Freshwater Cod, Black Cod and Estuary Cod (protected FM Act) to occur in the study area (Ecosense Consulting, 2008). The Oxleyan Pygmy Perch is known to occur in the study area including in Broadwater National Park, within MacDonalds Creek and near Rileys Hill and Lang Hill.	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act) Eastern (Freshwater) Cod (Endangered FM Act and EPBC Act) Black Cod (Vulnerable FM Act and EPBC Act) Estuary Cod (Protected FM Act)	McDonalds Creek Tuckombil Canal Rocky Mouth Creek Unnamed waterbodies
9	Tuckean Broadwater provides good potential habitat (paperbark and wallum heath swamp) in this section for the Oxleyan Pygmy Perch (Ecosense Consulting, 2008).	Oxleyan Pygmy Perch (Endangered FM Act and EPBC Act) Purple spotted Gudeon (Endangered FM Act)	SEPP 14 wetland No. 119 Tuckean Broadwater Montis Gully Eversons Creek

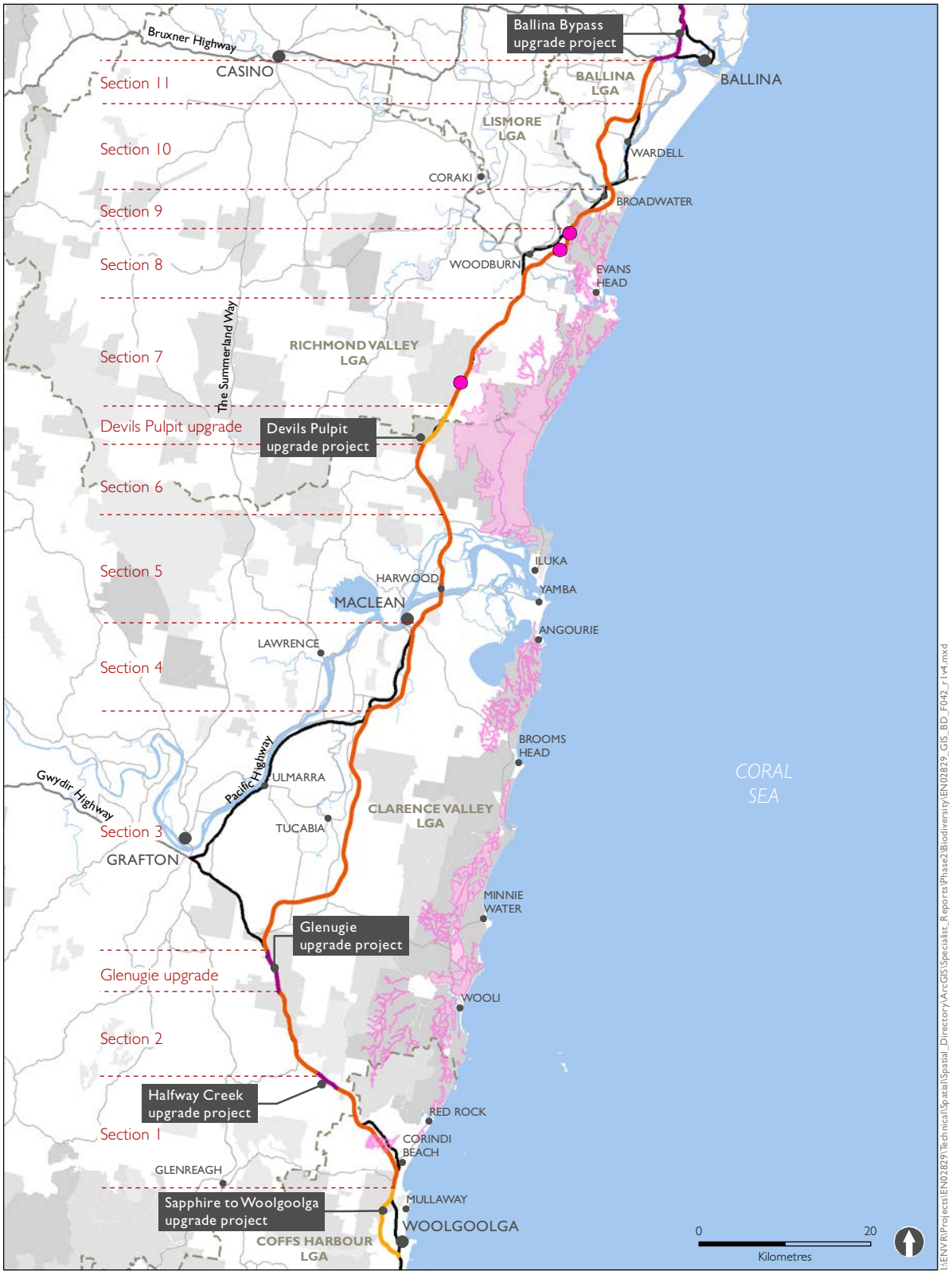
Project section	Notes on threatened fish species and habitat	Species	Potential habitat
10	There is potential for three threatened fish species (under the FM Act) to occur in the Richmond River: Eastern (Freshwater) Cod, Black Cod and Estuary Cod (Ecosense Consulting, 2008).	Eastern (Freshwater) Cod (Endangered FM Act and EPBC Act) Black Cod (Vulnerable FM Act and EPBC Act) Estuary Cod (Protected FM Act)	SEPP 14 wetland No. 118 and 118a Tuckean Swamp and Broadwater Richmond River
11	Due to the degraded nature of the waterways in this Section, the occurrence of threatened freshwater aquatic species is considered unlikely. However, Eastern (Freshwater) Cod potentially occurs in the upstream estuary of Emigrant Creek.	Eastern (Freshwater) Cod (Endangered FM Act and EPBC Act)	SEPP 14 wetland No. 95 and 108

3.9.7. Threatened invertebrates

Threatened invertebrates were encountered at two of 14 sites investigated in Section 9 to 11 during the field surveys. These comprised a single adult Atlas Rainforest Ground Beetle (Endangered TSC Act) and several Pink Underwing Moth larvae (Endangered TSC Act and EPBC Act) at two sites (Figure 3-59). No other conservation significant invertebrates were observed during the field surveys.

A total of 22 larvae of the Pink Underwing Moth were encountered. The majority of these (15 individuals) were found in a localised cluster of the host vine. Two host plants for conservation significant invertebrate species were recorded. This included several patches of *Carronia multisepalea* (host for the Pink Underwing Moth) in Section 10 and isolated occurrences of *Pararistolochia praevenosa* (host for the Richmond Birdwing) also in Section 10 (Figure 4-22). Both were found in regrowth rainforest, mostly growing on rich soil derived from basalt. *Carronia multisepalea* was recorded over an area of 0.2 hectares, 33 per cent of which falls within the project boundary.

Figure 3-81 *Oxleyan Pygmy Perch* recorded distribution and critical habitat in conservation reserves



3.10. Other species likely to occur in the study area

The previous sections identified the threatened biota that was identified in the study area from the ecological field surveys. Additional subject species are defined as threatened biota that were not identified from the surveys but that are considered to have a moderate to high likelihood of occurring based on the presence of local records and/or preferred habitat for the species (refer to Appendix D).

3.10.1. Threatened flora

The species listed in Table 3-21 are considered to have a moderate to high likelihood of occurring in the study area and therefore are subject to further assessment of impacts in Appendix E and summarised in Chapter 6.

Table 3-21: Additional threatened flora subject species

Scientific name	Common name	No. of records within 10 km of project (OEH 2012)	Status	
			TSC Act	EPBC Act
Acronychia littoralis	Scented Acronychia	39	V	E
Centranthera cochinchinensis	Swamp Foxglove	3	E1	-
Dendrobium melaleucaphilum	Spider Orchid	3	E1	-
Desmodium acanthocladum	Thorny Pea	4	V	V
Isoglossa eranthemoides	Isoglossa	1	E	E
Marsdenia longiloba	Slender Marsdenia	14	E	V
Oberonia titania	Red flowered King of the Faires	12	V	-
Peristeranthus hillii		7	V	-
Prostanthera palustris	Swamp Mint Bush	8	V	V
Quassia sp. 'Moonee Creek'	Moonie Quassia	70	E	E
Tinospora tinosporoides	Arrow Head Vine	51	V	V

3.10.2. Threatened fauna and invertebrates

The species listed in Table 3-22 have not been directly recorded in the study area from the preferred route field surveys although are considered to have a moderate to high likelihood of occurring in the study area and therefore are also subject to further assessment of impacts in Chapter 4 and Appendix E.

Table 3-22: Additional threatened fauna and invertebrate subject species

Scientific Name	Common Name	No. of records within 10 km of project	TSC Act	EPBC Act	Project section
Birds					
Amaurornis molucanna	Pale-vented Bush Hen	18	V		9-10
Stictonetta naevosa	Freckled Duck	3	V	-	3-5
Coracina lineata	Barred cuckoo-shrike	21	V	-	1-2, 6-11
Cyclopsitta diophthalma coxeni	Double-Eyed Fig-Parrot	0	CE	E1	9-11
Erythrotriorchis radiatus	Red Goshawk	15	CE	V	1-11
Hieraaetus morphnoides	Little Eagle	36	V	-	1-11
Irediparra gallinacea	Comb-Crested Jacana	48	V	-	3-9
Ixobrychus flavicollis	Black Bittern	15	V	-	1-3, 6-7, 9
Rostratula australis	Australian Painted Snipe	1	E	V	1-11
Glossopsitta pusilla	Little Lorikeet	104	V		1-11
Lathamus discolor	Swift Parrot	17	E	E, Mi	1-11
Lichenostomus fasciogulari	Mangrove Honeyeater	62	V		4-5, 8-10
Lophoictinia isura	Square-tailed Kite	36	V	-	1-11
Ninox connivens	Barking Owl	49	V	-	1-11
Pezoporus wallicus wallicus	Ground Parrot (eastern subsp.)	57	V	-	8-10
Ptilinopus magnificus	Wompoo fruit-Dove	155	V	-	1-2, 6-11
Ptilinopus regina	Rose-crowned Fruit Dove	124	V	-	1-2, 8-11
Ptilinopus superbus	Superb fruit-Dove	10	V	-	1-2, 8-11
Tyto capensis	Grass Owl	78	V	-	1-11
Xanthomyza phrygia	Regent Honeyeater	5	E1	E, Mi	1-11
Invertebrates					
Petalura litorea	Coastal Petaltail	1	E		7-10
Mammals					

Scientific Name	Common Name	No. of records within 10 km of project	TSC Act	EPBC Act	Project section
Chalinolobus dwyeri	Large-eared Pied Bat	1	V	V	1-7
Mormopterus beccarii	Beccari's Freetail-Bat	4	V	-	1-11
Cercartetus nanus	Eastern Pygmy-Possum	1	V	-	1-11
Dasyurus maculatus maculatus (SE population)	Spotted-tailed Quoll	64	V	E1	1-11
Potorous tridactylus tridactylus	Long-Nosed Potoroo	9	V	V	1-3, 6-11
Amphibians					
Litoria olongburensis	Olongburra Frog	31	V	V	1-11
Reptiles					
Hoplocephalus bitorquatus	Pale-headed Snake	0	V	-	1-3, 6-8

3.10.3. Threatened fish

The species listed below in Table 3-23 were not recorded during targeted surveys within the study area, however are considered to have a moderate to high likelihood of occurring in the study area and therefore are subject to further assessment in Chapter 4.

Table 3-23 Potential threatened fish subject species

Species	Status		Reported distribution and habitat type
	FM Act	EPBC Act	
Eastern (Freshwater) Cod	E	E	The species is known only from the Clarence and Richmond rivers, where it was formerly abundant. Since the late 1960s, only small numbers of cod (usually less than 5 kg) have been caught and only from tributaries such as the Nymboida, Little Nymboida, Guy Fawkes, Boyd and Mann rivers, where some pristine habitat still exists. The cod in these rivers are considered to comprise one population. Likely to inhabit clear flowing streams with rocky beds, deep holes and where there is an abundance of snags and riparian vegetation. Potential habitat in middle section of Coldstream River, Chaffin Creek and Pillar Valley creek (Section 6). Also potential to occur in Section 2 and Section 8, known to occur in region of Section 3, and major tributaries of Clarence River (Section 5).
Purple spotted Gudgeon	E		Small freshwater fish occurring in coastal drainages of northern NSW. Found in slow moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large woody debris.

3.11. Emu vehicle collision study

3.11.1. Temporal patterns in frequency of road-kills

There were 48 reported emu road-kills from the Atlas of NSW Wildlife for the study area during the period 1980 to 2011. Between 1980 and 2005 ten emu road-kills were reported. From 2005 onwards road-kills were more regularly reported (Figure 3-82). Aside from the increased regularity in reporting, there is little pattern in the number of reports of emus killed on roads in the study area. However, it is apparent an atypical number of emu road-kills were reported in 2006 and 2009. The reports from 2006 were single fatalities. The reports from 2009 were for 14 separate incidents, with three occasions of more than one emu being killed at one time.

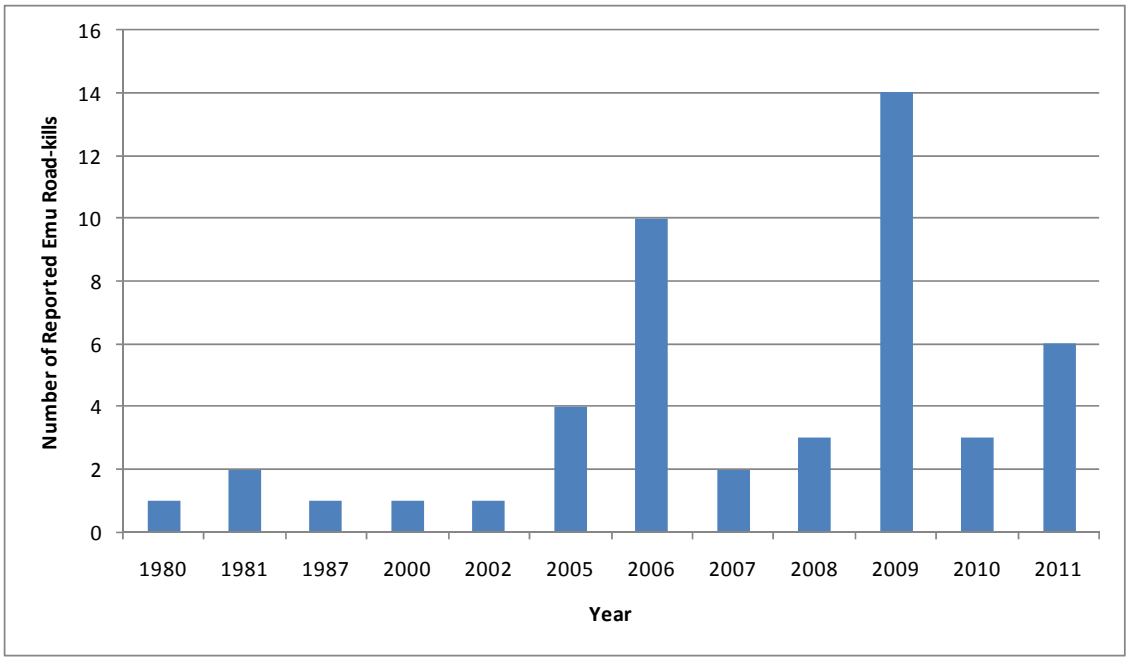


Figure 3-82: Number of emu road-kills reported per year during the period 1980-2011.

There was also little pattern in seasonal reporting of emu road-kills in the study area (Figure 3-83). Emu road-kills were reported throughout the year in similar numbers, except for April. An Analysis of Variance (ANOVA) test to determine whether there was a statistically significant difference in the number of emu road-kills reported each month revealed no significant difference. The higher number of reported road-kills in April is attributable to collisions in 2006 and 2009.

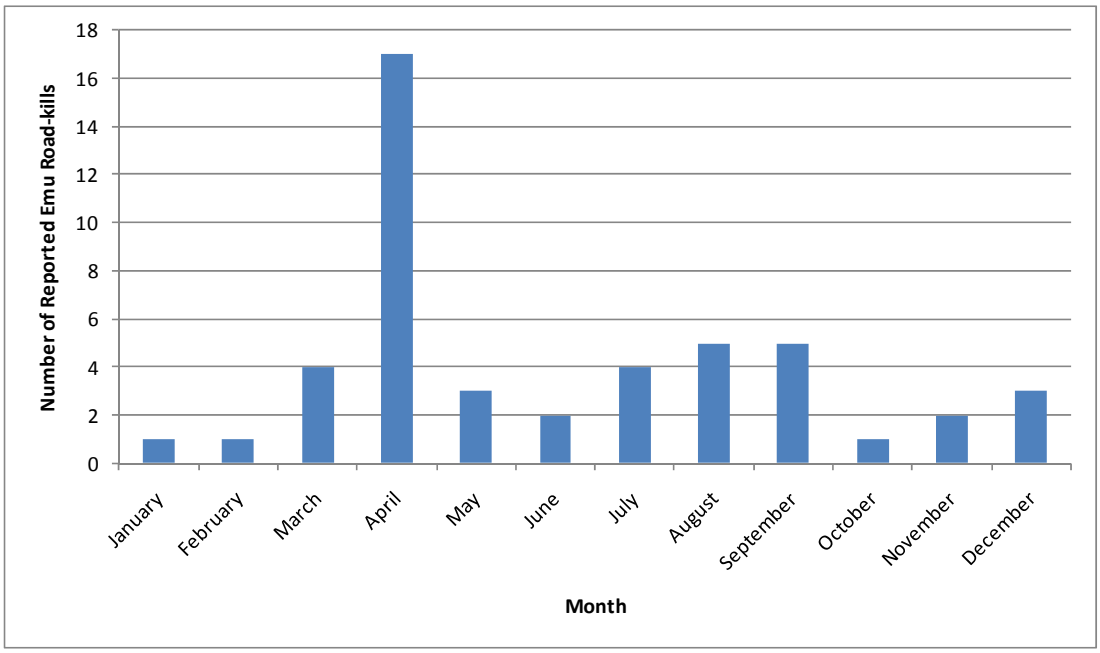


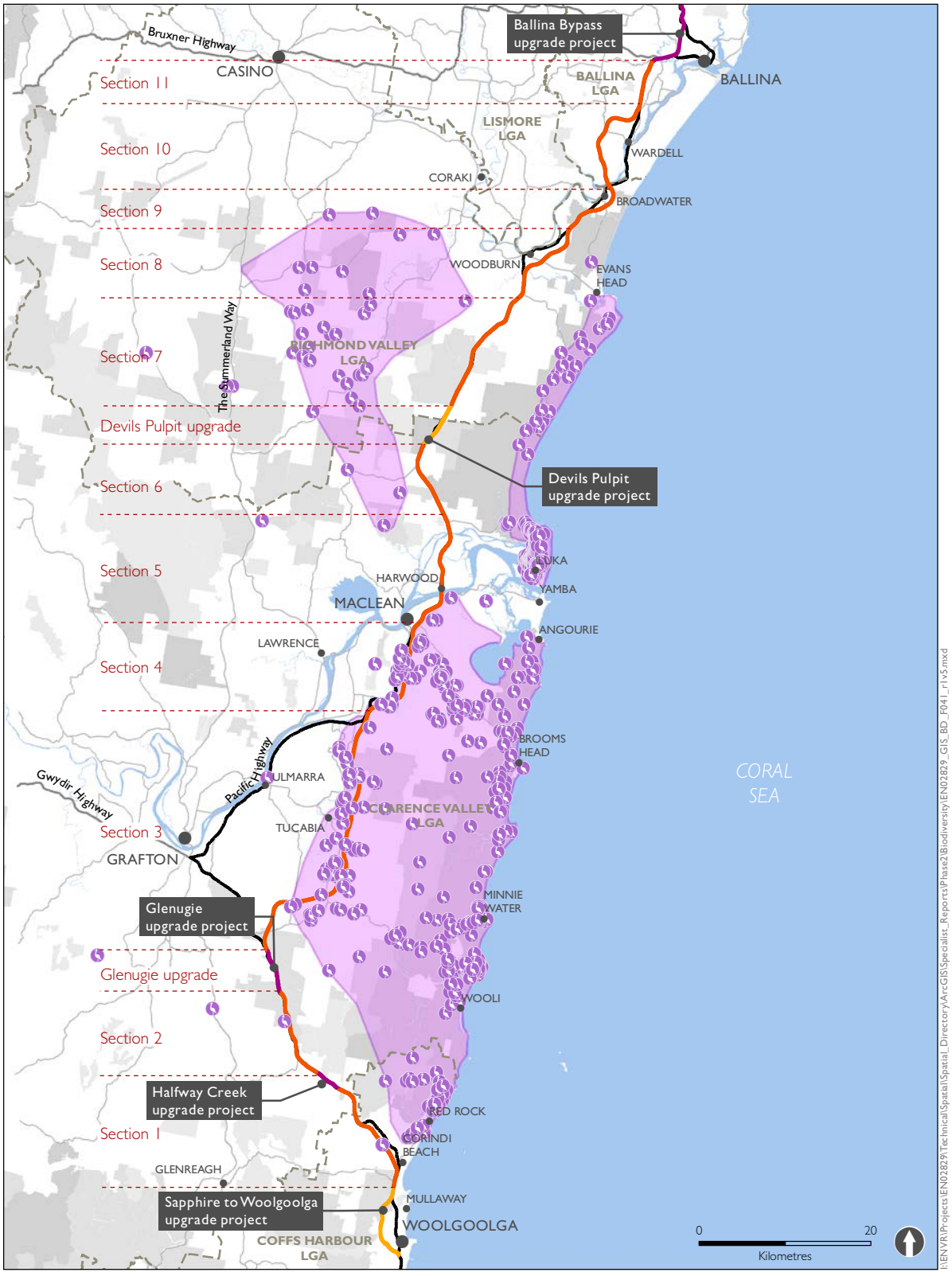
Figure 3-83: Seasonal variation in reported emu road-kills, during the period 1980-2011.

3.11.2. Spatial patterns in road-kills

All reported road-kills have been mapped to depict any spatial patterns (Figure 3-84). Road-kills are clustered near the coastal villages of Corindi Beach, Red Rock, Wooli and Brooms Head in the east, along Wooli/Tucabia Road in the west, and the connecting roads in-between. North of the Clarence River, there are a number of road-kills at Iluka on the coast, and along the coast north to Evans Head. With the exception of one incident at Ulmarra, there were no reported road-kills along the existing Pacific Highway during the period 1980-2011.

Consideration of the type and size of the roads revealed little difference in the total number of emus killed on dirt versus sealed roads (19 and 18 emu collision sites respectively), but there was an interaction between the type and size of roads. Most emu collision sites were narrow dirt roads (defined as < 5.6 metres wide), and sealed rural roads with either two lanes or slightly narrower with no marked dividing line (Figure 3-85). These are the most common road types in the study area; hence most emu collisions are expected to occur on these roads.

Figure 3-84 Spatial distribution of emu records in the locality from the period 1980-2011



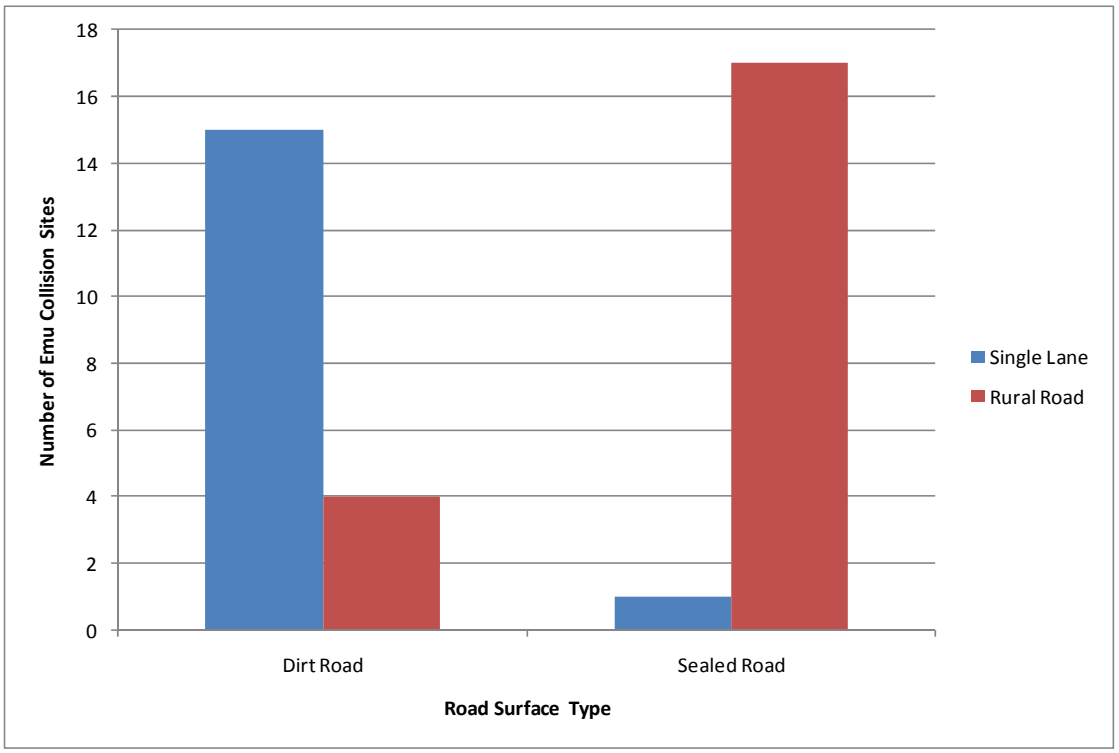


Figure 3-85: Comparison of emu collision sites according to road surface and size.

3.11.3. Site characteristics and road-kills

Relationships between site characteristics and the probability of an emu road-kill were tested using chi-square tests of association. Prior to conducting the chi-square tests all site characteristics measured in the field were subjected to a correlation test. This eliminated several highly-correlated characteristics from further analyses and focused the analyses on testing for associations between independent site variables.

Significant associations occurred between several of the site characteristics and the site type (ie control or road-kill) (Table 3-24). Emu road-kill sites were typically:

- Within 10 metres of mature forest along the roadside with 6-50 per cent canopy cover, rather than cleared landscapes
- On single lane dirt roads or larger sealed rural roads
- Where there was no fence between the forest edge and the road
- Where there was vegetation two metres or taller within five metres of the edge of the road.

The road speed limit, adjacent speed limits, road gradient, type or condition of paddock fences, shrub and groundcover were identified to not be influential in typical emu road-kill locations.

Table 3-24: Chi square tests of association between road characteristics and emu road-kills.

Test	Compared	Chi-square value	Degrees of freedom	P
Road Characteristics				
Road speed	50 v 60 v 80 v 100 kilometres/hr	1.83	2	0.40
Road surface	dirt* v concrete v tar* v other	10.88	3	0.01
Road size	1.5* v 2* v 2 v 4 lanes		3	0.00
Vertical character	steep v gentle v flat v other	4.27	3	0.23
Slope of roadside verge	cut v fill v flat	4.05	2	0.13
Adjacent speed limit	50 v 60 v 80 v 100 kilometres/hr	5.48	3	0.13
Vegetation Characteristics				
Forest age	Mature* v regenerating	7.98	1	0.00
Distance to vegetation >2 m tall	0-5* v 6-10 v 11-49 v >50 m	11.41	3	0.01
Top height of the average shrub	none v 1-3 v 3-5 v 5-7 m	3.25	3	0.35
Top height of the average tree	0-5 v 6-12 v 13-35 m	5.62	2	0.13
Canopy cover	0-5 v 6-20* v 21-50* v 51-80 %	13.62	3	0.00
Shrub cover	0-5 v 6-20 v 21-50 v 51-100 %	3.41	3	0.33
Ground cover	0-5 v 6-20 v 21-50 v 51-100 %	3.50	3	0.32
Adjacent Land Characteristics				
Adjacent land use	cleared v vegetated* v other	15.95	2	0.00
Distance to water	0-40* v 41-100 v >101 m	19.55	2	0.00
Adjacent waterbody type	none* v farm dam v wetland* v stream	16.16	3	0.00
Fence Characteristics				
Fence	fence v no fence*	20.92	1	0.00
Fence type	barbed wire v plain wire v other	2.15	2	0.54
Fence condition	good v moderate v poor v other	2.94	3	0.40

** The significant predictor of an emu collision site*

3.11.4. High risk locations for emu collisions

The information obtained from the analysis of vehicle collision sites was used to predict and rank the risk of emu collisions along the project boundary in the critical emu areas identified between Eight Mile Lane at Glenugie and McIntyres Lane at Tyndale (Sections 3 and 4). This information is presented in Appendix A - Biodiversity Connectivity Strategy.