4. Species, populations and communities of conservation concern

This Chapter describes the Threatened biodiversity and other species of conservation concern likely to occur within the study area based on those found within the Proposal locality and the nature of the habitats within the existing environment.

4.1 Matters of National Environmental Significance

Matters of National Environmental Significance are listed and protected under the *Environment Protection and Biodiversity Conservation Act 1999*. The Act identifies seven Matters of National Environmental Significance:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).

Matters of National Environmental Significance relating to biodiversity are discussed below in relation to the Proposal based on the results of the *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters Search Tool (Department of the Environment Water Heritage and the Arts 2008b), desktop review of databases and literature, and the results of field surveys.

A summary of Matters of National Environmental Significance is provided below and the likely impacts of the proposed Tarcutta Bypass on them are presented in Appendix E of this Technical Report.

4.1.1 Threatened ecological communities

One Threatened ecological community listed as Critically Endangered was recorded within the study area and is discussed below.

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and derived Native Grassland

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland) was the only Threatened ecological community recorded in the study area listed under the *Environment Protection and Biodiversity Conservation Act 1999.*

The original extent of this community has been significantly reduced as a result of land clearing associated with grazing, agricultural practices and other land uses. Within the Tarcutta area, approximately 93 per cent of the original extent of this community has been cleared (Threatened Species Scientific Committee 2006).

Box-Gum Woodland is listed as a Critically Endangered Ecological Community under the Act.

The Threatened Species Scientific Committee (Commonwealth) has identified that this ecological community occurs in a range of conditions, including:

- Where overstoreys of eucalypt trees exist, but there is no substantial native understorey.
- Where native understoreys exist, but the trees have been cleared.
- Where both native understoreys and overstoreys of eucalypts exist together (Threatened Species Scientific Committee 2006).

The process for identifying the presence of the community is presented in Figure 4-1 and is described in more detail below, considering the various criteria for classification of the vegetation as part of the listed community.

In addition to the identification guidelines presented in Figure 4-1, the advice of the Threatened Species Scientific Committee to the Minister for the Environment and Heritage and final determination for this community were considered in determining the presence of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (2006b).

Patch size

An important element of determining if vegetation is part of a listed community is determining its patch size. The *Environment Protection Biodiversity Conservation Act Policy Statement* (Department of the Environment and Heritage 2006b) indicates that a patch is a continuous area that contains the ecological community. The Policy indicates that a patch is the larger of:

- an area that contains five or more trees in which no tree is greater than 75 metres from another tree, or
- the area over which the understorey is predominantly native.

Within the study area, remnant vegetation occurs as relatively small remnants, containing trees, interspersed by areas of modified vegetation (refer Figure 4-2). In order to determine which remnants should be combined into which patch, the mapped extent of the vegetation within each study area was buffered by 37.5 metres using a GIS system to determine those remnants that were within 75 metres of each other.

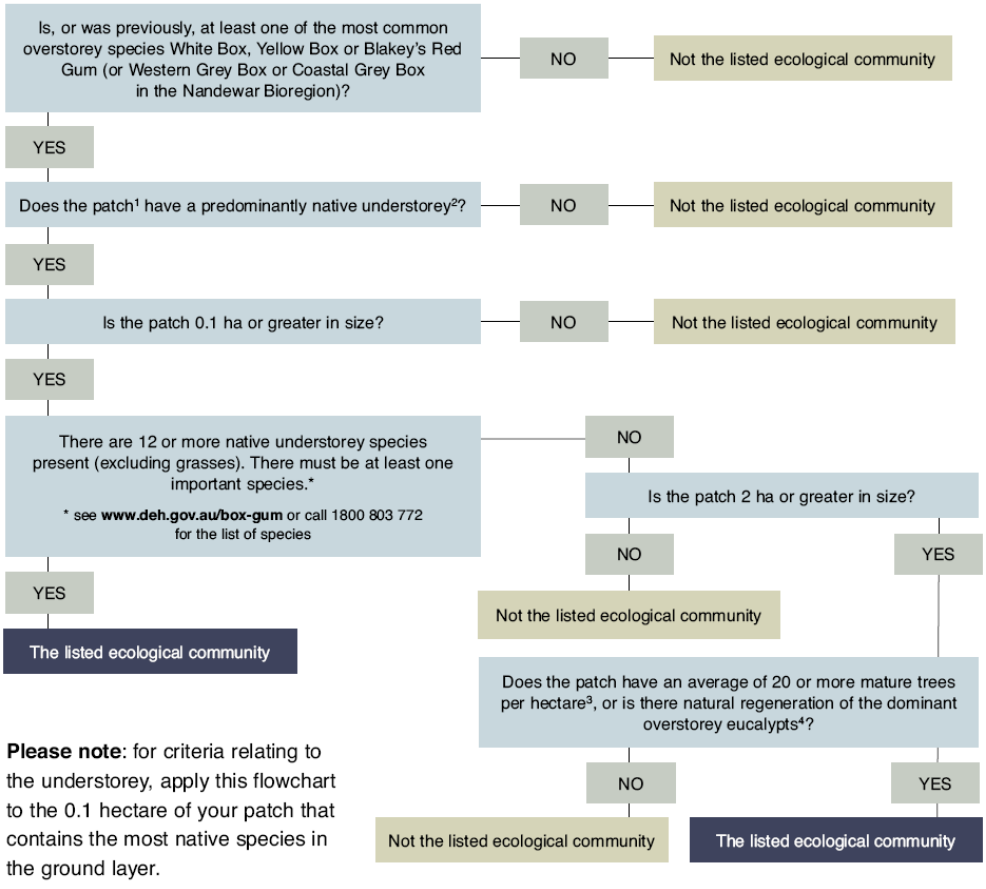
A small number of the remnants within the south of the study area were within 75 metres of the next adjacent remnant; as such, these remnants can be incorporated into a single patch (refer Figure 4-2). This creates long, linear patches on either side of the road and increases the cumulative area of the patch (i.e. interspaces in the mapped vegetation are included in the patch).

The buffers were used specifically to identify each of the distinct remnant patches, in accordance with the Figure 4-1 and were not included in the final clearing calculations and impact assessments.

The majority of the remnants north of the Tarcutta village consisted of small, isolated patches surrounded by other vegetation types.

Six distinct remnant patches were identified within the study area combining both the roadside remnants along the existing Hume Highway, to the north and south of Tarcutta and

the large remnant patches within the local Travelling Stock Reserve (refer Figure 4-2 and Figure 4-3). Of these six patches, three meet the various criteria to be included as part of the listed community (refer Table 4-1). Patch 2, 3 and 4 did not have the necessary cover of natives to qualify as the Critically Endangered Ecological Community.



Please note: for criteria relating to the understorey, apply this flowchart to the 0.1 hectare of your patch that contains the most native species in the ground layer.

[1] Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:
- an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
- the area over which the understorey is predominantly native.

Patches must be assessed at a scale of 0.1 ha (1000m^2) or greater.

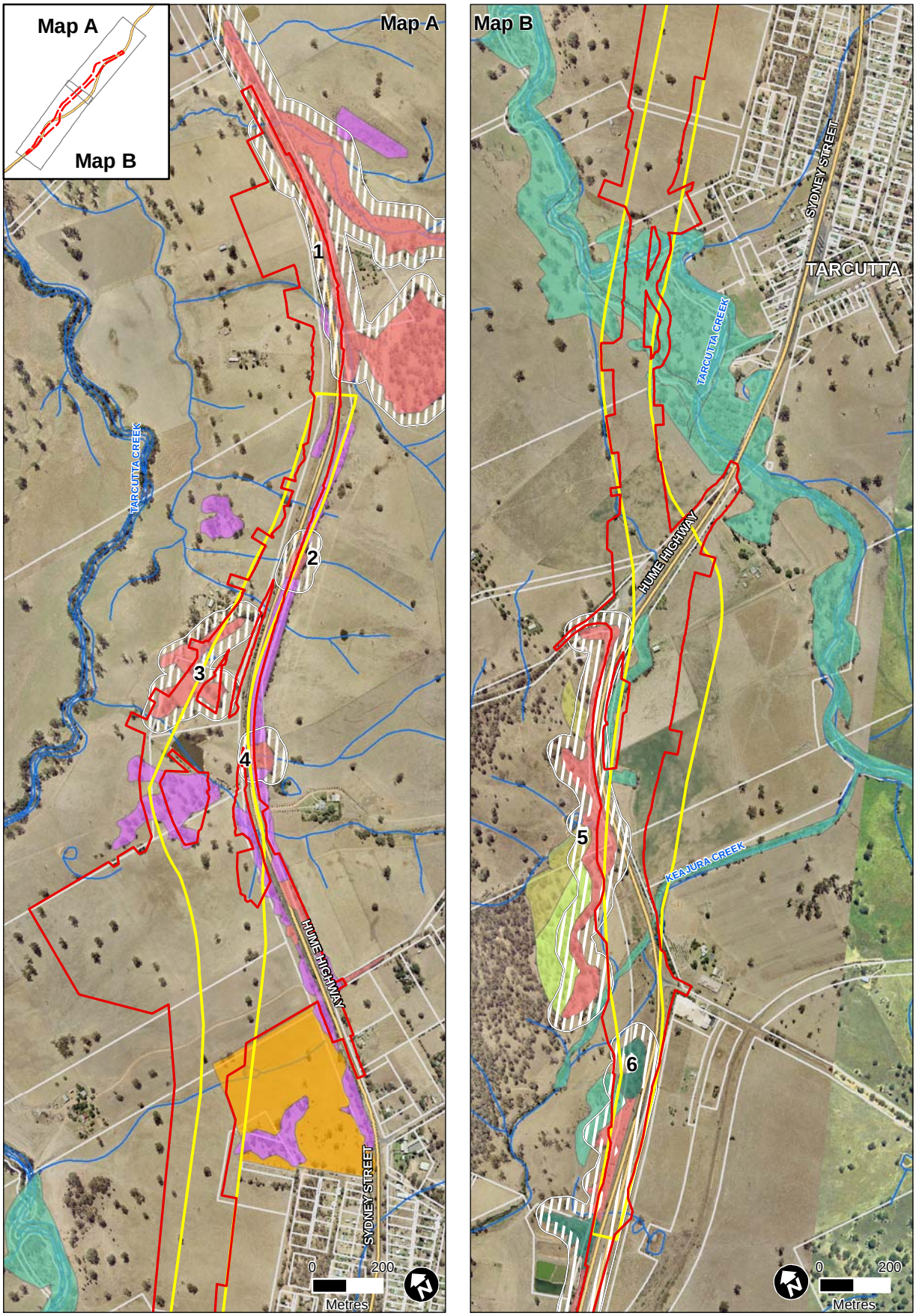
[2] A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not is if it is difficult to pull out of the soil. Annual species pull out very easily.)

[3] Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.

[4] Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.

Source – Department of the Environment and Heritage (Department of the Environment and Heritage 2006b)

Figure 4-1 Determination of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland under the *Environment Protection and Biodiversity Conservation Act 1999*



*EEC = Endangered Ecological Community

Figure 4-2 Islands of remnate vegetation and patch size

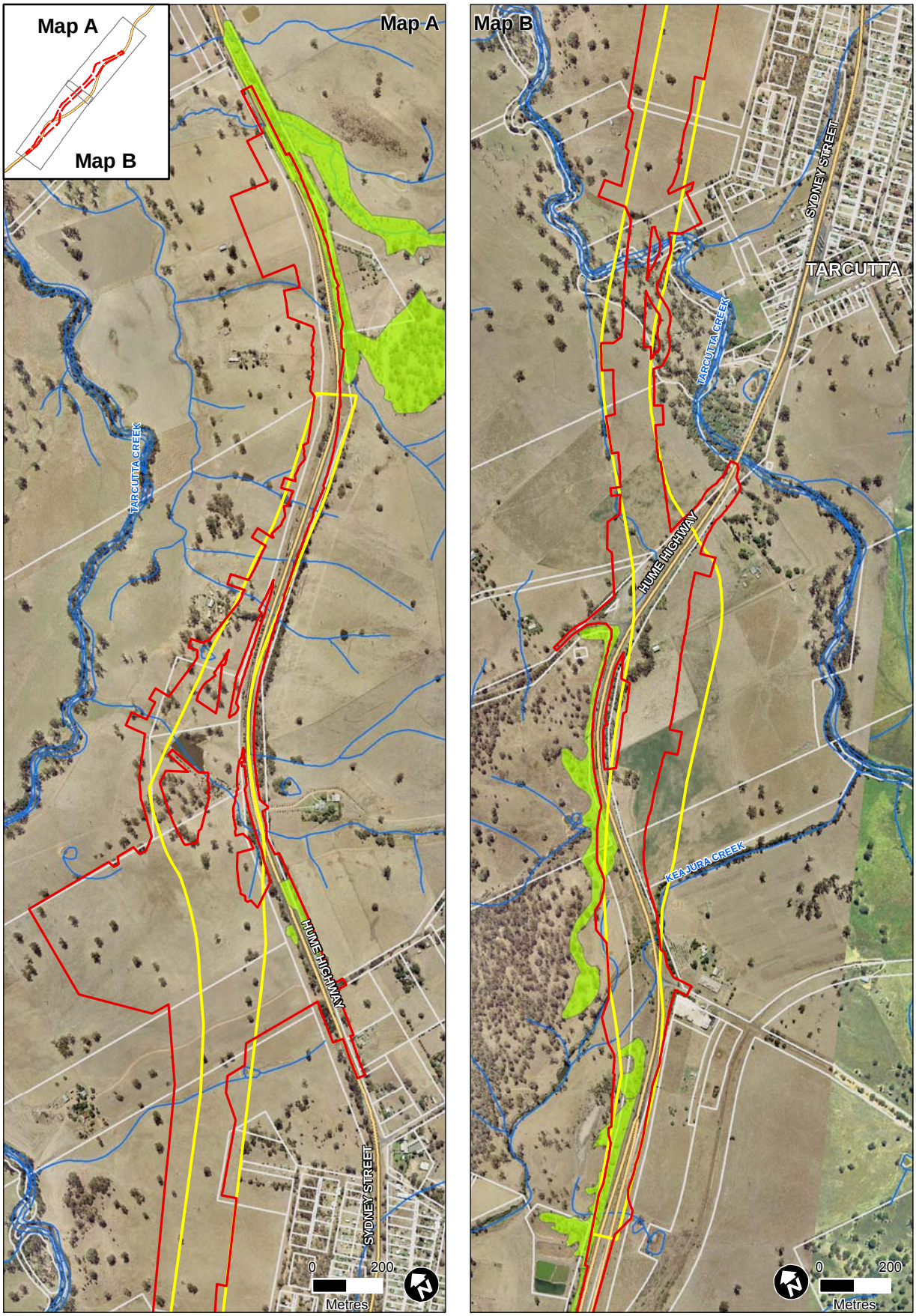


Figure 4-3 White Box – Yellow Box – Blakely's- Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act)

Table 4-1 Summary table of EPBC determination of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland for each patch

Step	EPBC Criteria for determining White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	General Comment for all patches within the study area	Patch Number					
			1	2	3	4	5	6
1	**Is, or was previously, at least one of the most common overstorey species White Box, Yellow Box or Blakely's Red Gum?**	The three vegetation communities that have been included in the definition of White Box, Yellow Box, Blakely's Red Gum Woodland all include White Box, Blakely's Red Gum or Yellow Box as a dominant over storey species.	**Yes (go to 2)**	**Yes (go to 2)**	**Yes (go to 2)**	**Yes (go to 2)**	**Yes (go to 2)**	**Yes (go to 2)**
2	**Does the patch have a predominantly native understorey?**	The EPBC Act Policy Statement (Department of the Environment and Heritage 2006b) indicates that a predominantly native ground layer exists where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. Results have been extrapolated from randomly placed 400 square metre quadrats and transects not necessarily located in the 0.1 hectare of each patch containing the highest quality of native vegetation. In some cases the dominance of native species observed during random transects was used to assume the likelihood of a greater than 50 per cent native perennial groundcover in best 0.1 hectares.	**Yes. Up to 60% in roadside reserve (go to 3)**	**No <35%** (go to end)	**No <20%** (go to end)	**No <35%** (go to end)	**Yes, up to 80% in Travelling Stock Reserve (go to 3)**	**Yes up to 50% in roadside reserve (go to 3)**
3	**Is the patch 0.1 hectares or greater in size?**	Because of the definition of a patch (refer above), all patches within the study areas are greater than 0.1 hectares in size (see).	**Yes (go to 4)**	NA	NA	NA	**Yes (go to 4)**	**Yes (go to 4)**

Step	EPBC Criteria for determining White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	General Comment for all patches within the study area	Patch Number					
			1	2	3	4	5	6
4	**Are there 12 or more native understorey species present (excluding grasses), with at least one important species?**	Throughout the remnant patches the groundcover was the most diverse stratum within this community, typically comprising a variety of native and exotic grasses, sedges and herbs. The average number of understorey native species (excluding grasses) sampled per 400 square metre quadrat varied from two to seven.	**No**. 8 natives (1 site) excluding grasses. A total of 3 important species (go to 5)	NA	NA	NA	**Yes**. 27 natives (4 sites) excluding grasses. A total of 5 important species (go to 5)	**Yes**. 14 natives (2 sites) excluding grasses. A total of 1 important species (go to 5)
5	**Is the patch 2 hectares or greater in size?**	All patches within the study area, as defined under the EPBC Act Policy Statement (Department of the Environment and Heritage 2006b) (refer above), are larger than 2 hectares (refer Figure 4-2).	**Yes (go to 6)**	NA	NA	NA	**Yes (go to 6)**	**Yes (go to 6)**
6	**Does the patch have an average of 20 or more mature trees per ha, or is there natural regeneration of the dominant overstorey Eucalypts?**	All patches within the study area contain natural regeneration of the dominant overstorey Eucalypts.	**Yes** (go to end)	NA	NA	NA	**Yes** (go to end)	**Yes** (go to end)
	Does patch meet the various criteria for classification of the vegetation as the listed community?		**Yes**	**No**	**No**	**No**	**Yes**	**Yes**
END	**Does patch meet final determination of the listed community (Department of the Environment and Heritage 2006b)?**		**Yes**	**No**	**No**	**No**	**Yes**	**Yes**

Inland Grey Box Woodland

The Scientific Committee has made a preliminary determination to list Inland Grey Box Woodland as a Vulnerable Ecological Community under the *Environment Protection and Biodiversity Conservation Act 1999*. The Grey Box Woodland is found in Queensland, New South Wales, Victoria and South Australia. The community is characterised by the dominance of *Eucalyptus microcarpa* (Grey Box) and *E. melliodora* (Yellow Box). Structurally the community is a mid-high to tall woodland, with trees up to 25 metres tall with a sparse shrub layer and mainly grassy ground layer. Other characteristic trees present include *Callitris glaucophylla* (White Cypress Pine), *Allocasuarina luehmannii* (Buloke), and in some areas, *E. albens* (White Box). The ground layer of the community is often sparse or grassy with species including *Enteropogon ramosus* (Curly Windmill-grass), *Austrostipa scabra* (Spear-grass) and *Cymbopogon refractus* (Barbed Wire-grass). The shrub layer is sparse with a variable species composition. The ecological community occurs on productive alluvial or colluvial, mostly loamy soils.

Derived grassland may be a part of the ecological community, that is, grassland on sites formerly known to have had this ecological community but now cleared of overstorey trees. Where the understorey is largely intact and tree crown cover is known to have been cleared to < 10%, it is treated as derived grassland.

Within the study area, the community Inland Grey Box tall grassy woodland and the derived grasslands correspond with this community (Figure 4-3).

Condition Thresholds for Inland grey box Woodland

The Scientific Committee has developed a number of condition thresholds to assist in the determination of a native vegetation remnant belonging to the listed ecological community (see Table 4-2). Condition can be determined by factors such as: numbers and types of native plants and animals present; the level of weed invasion; the size of an area; and distance to the next area of native vegetation. Significantly degraded areas, that is, areas that don't meet the condition thresholds below, will not be part of the listed ecological community.

Table 4-2 Summary table of condition thresholds for determining the EPBC preliminary listing of Inland Grey Box Woodland

Patch size	Condition criteria for determining the EPBC preliminary listing of Inland Grey Box Woodland	General Comment for all remnant patches within the study area
Small # * (>0.1 to 2 ha)	A tree canopy is present and dominated (> 50%) by *E. microcarpa*.; AND At least 50% of the vegetative cover in the ground layer is made up of perennial native species; AND ≥8 native species are present in the understorey layer at any time of the year, including grasses, other graminoids, forbs and low to medium shrubs (excluding shrubs >2 m high).	All small remnants of Inland Grey Box Woodland vegetation community within the study area are: ▪ dominated by >50% *E. microcarpa* ▪ have a ground layer with >50% vegetation cover made up of native species ▪ have > 8 native species in the understorey.

Patch size	Condition criteria for determining the EPBC preliminary listing of Inland Grey Box Woodland	General Comment for all remnant patches within the study area
Large # * (>2 ha)	A tree canopy is present and dominated (> 50%) by *E. microcarpa*.; AND EITHER At least 8 trees/ha are hollow bearing and/or have a diameter at breast height of 80 cm or more AND at least 10% ground cover of perennial native grasses OR at least 20 trees/ha have a diameter at breast height of 12 cm or more (dead trees are included) AND at least 50% cover in the ground layer is made up of perennial native species.	All large remnants of Inland Grey Box Woodland vegetation community within the study area have: ▪ a canopy dominated by >50% *E. microcarpa*. ▪ a ground layer with >50% vegetation cover made up of native species ▪ At least 20 trees/ha have a diameter at breast height of 12 cm or more (dead trees are included) Or ▪ 8 hollow bearing trees/ha and/or have a diameter at breast height of 80 cm or more ▪ at least 10% ground cover of perennial native grasses.
Derived # * Grassland (>0.1ha with canopy <10%)	There must be evidence (e.g. through stumps, historical records, surrounding vegetation) that there was a tree canopy formerly dominated by *E. microcarpa*; AND at least 50% of the vegetative cover in the ground layer is made up of perennial native species AND ≥12 native species are present in the understorey layer at any time of the year, including grasses, other graminoids, forbs and low to medium shrubs (excluding shrubs >2 m high).	The Derived Grassland vegetation community within the study area has; ▪ evidence of a tree canopy formerly dominated by *E. microcarpa* ▪ a ground layer with >50% vegetation cover made up of native perennial species ▪ ≥12 native species are present in the understorey layer at any time of the year.
END	**Does the vegetation meet preliminary determination of the listed community**	**Yes, All remnant patches of Inland Grey Box Woodland and Derived Grassland vegetation communities within the study area meet the condition criteria.**

Weed Threshold: Non-grassy weeds (exotic plant species) not to be greater than 30% of vegetative cover (in the ground layer).

* Patches must be assessed at a scale of 0.1 ha/0.25 acre (1000m^2) or equivalent.

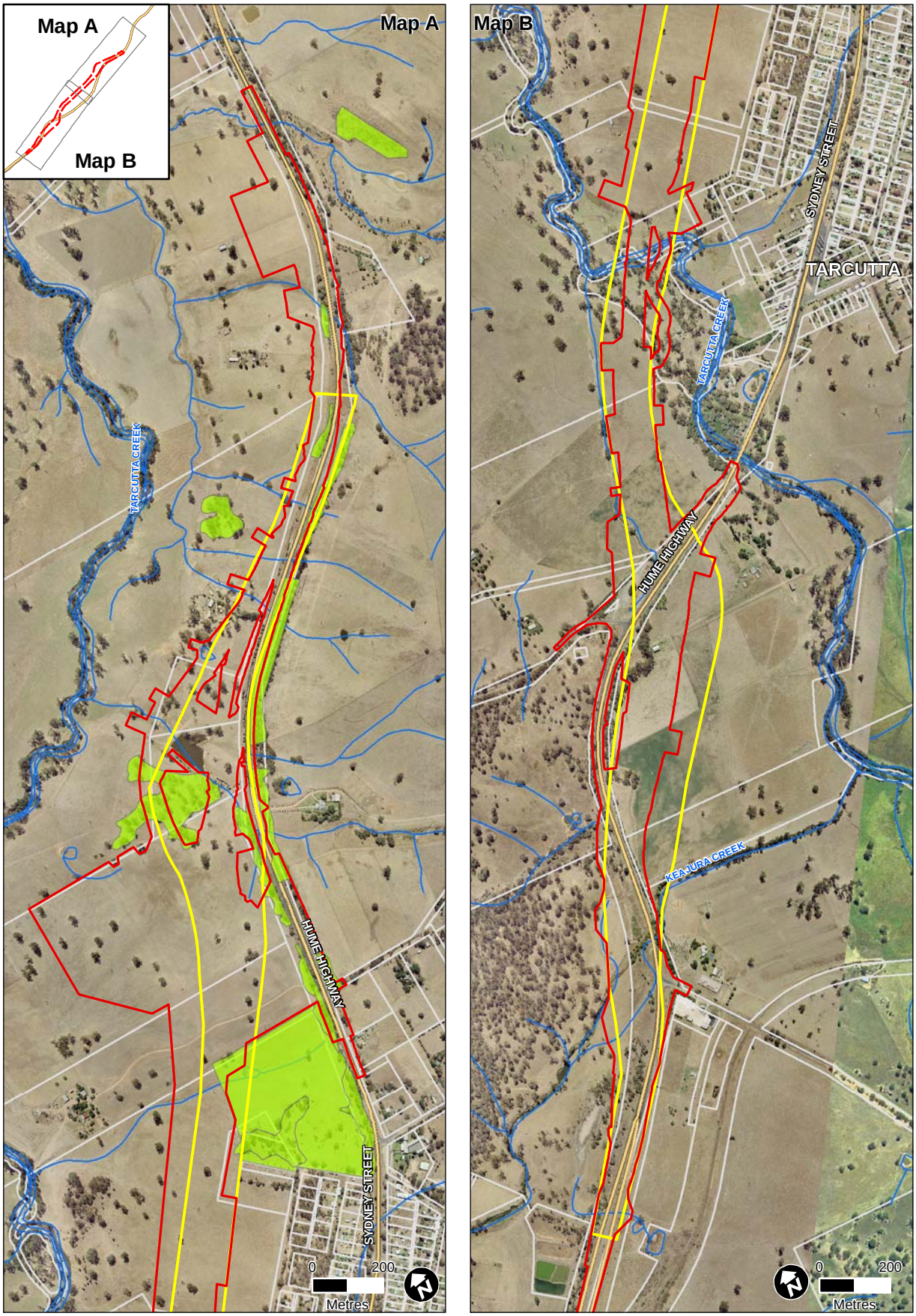


Figure 4-4 Inland Grey Box Tall Grassy Woodland
(TSC Act and preliminary listing under the EPBC Act)

4.1.2 Threatened species

Eleven Threatened floral species have been recorded, are predicted to occur or have habitat in the locality (10 kilometres radius) of the study area as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment, Water, Heritage and the Arts, accessed 19 November 2008).

Three of these species are considered to have a Moderate Likelihood of occurrence based on potential habitat and a precautionary approach to their cryptic flowering survey requirements.

Twelve Threatened fauna species have been recorded, are predicted to occur, or have potential habitat in the locality (10 kilometre radius) of the study area as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment, Water, Heritage and the Arts, accessed 1 December 2008). This comprised two species of amphibian, two species of reptile, four species of bird, two species of mammal and two species of fish (refer Table 4-2). Details of these species are provided in Appendix D. No Threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* were recorded during current surveys.

Table 4-2 Threatened species of animal predicted to occur within the Proposal locality based on database search results

Group	Number of species
Amphibians	2
Birds	4
Mammals	2
Reptiles	2
Fish	2
TOTAL	**12**

It is unlikely, however, that all these species would be affected by the Proposal (refer Appendix D). Despite the existence of records in the locality, six Threatened species are considered to have a low likelihood of occurring in the study area due to a lack of suitable habitat, including Booroolong Frog, Southern Bell Frog, Painted Snipe, Spotted-tailed Quoll, Murray Cod and Macquarie Perch. Full details of species requirements and reasons for not considering impacts of the Proposal further are provided in Appendix D.

Significance assessments required under the *Environment Protection and Biodiversity Conservation Act 1999* have been completed for the remaining six species (refer Section 7 and Appendix E), which includes Swift Parrot, Superb Parrot, Regent Honeyeater, Greater Long-eared Bat, Pink-tailed Worm Lizard, and Striped Legless Lizard.

4.1.3 Migratory species

Migratory species are protected under the international agreements to which Australia are a signatory, including JAMBA, CAMBA, RoKAMBA and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered Matters of National Environmental Significance and are protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

Two species of bird, Great Egret and Rainbow Bee-eater, recorded during field surveys are currently recognised under the migratory provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (refer Appendix B). A further seven species have the potential to occur in the Proposal locality based on the Department of the Environment, Water, Heritage and the Art's *Protected Matters Search Tool*. This includes Fork-tailed Swift, Cattle Egret, Latham's Snipe, White-bellied Sea-Eagle, White-throated Needletail, Painted Snipe and Regent Honeyeater.

Under the *Environment Protection and Biodiversity Conservation Act 1999*, an action is likely to have a significant impact on a migratory species if it substantially modifies, destroys or isolates an area of important habitat for the species (Department of the Environment and Heritage 2006a).

For eight species of migratory bird recorded or considered likely to occur, the study area is not considered to comprise important habitat as it does not contain:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species.
- Habitat that is of critical importance to the species at particular life-cycle stages.
- Habitat used by a migratory species that is at the limit of the species' range.
- Habitat within an area where the species is declining (Department of the Environment and Heritage 2006a).

As such, impacts of the Proposal on migratory species are not considered further for these species.

One of the species — Regent Honeyeater — is, however, listed as Endangered and as such, the study area could be considered to contain habitat where the species is declining. For species listed as migratory and threatened under the *Environment Protection and Biodiversity Conservation Act 1999*, assessments of significance are carried out using the threatened species criteria (refer Section 7 and Appendix E).

4.1.4 World heritage properties

No world heritage properties are within the locality of the Proposal.

4.1.5 Ramsar wetlands

No Internationally important wetlands (Ramsar sites) are mapped within the locality of the study area. However, Fivebough and Tuckerbil Swamps (Ramsar Wetlands) are located in the Murrumbidgee Catchment, but are located approximately 172 kilometres from the subject site and study area. As such, the Proposal is not likely to have an adverse effect on any Ramsar Wetland either directly or indirectly.

4.2 State-listed species and communities

4.2.1 Threatened ecological communities

Two Threatened ecological communities listed under the *Threatened Species Conservation Act 1995* and one under the *Fisheries Management Act 1994* occur within the study area and these are discussed below.

4.2.2 White Box, Yellow Box, Blakely's Red Gum Woodland

White Box, Yellow Box, Blakely's Red Gum Woodland is listed as an Endangered Ecological Community under the *Threatened Species Conservation Act 1995*.

The final determination for this community under the *Threatened Species Conservation Act 1995* is broad, with five main features defining whether a patch is consistent with the community determination:

- Whether the site is within the area defined in the determination.
- Whether the characteristic trees of the site are (or are likely to have been) White Box, Yellow Box or Blakely's Red Gum.
- Whether the site is mainly grassy.
- Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).
- If the site is degraded, whether there is potential for assisted natural regeneration of the overstorey or understorey (NSW National Parks and Wildlife Service 2002a, 2002c; Prober & Thiele 1995).

Two of the vegetation communities within the study area are consistent with these first four criteria. These are:

- Blakely's Red Gum-Yellow Box grassy woodland.
- Apple Box moist gully grass-forb open forest.

Degraded remnants and scattered trees may be included in the definition of the community if sufficient natural soil and seedbank remain, so that under appropriate management, assisted natural regeneration of the overstorey or understorey could occur.

To determine the potential for assisted regeneration within each patch, an assessment according to one of the five condition criteria identified by the Box-Gum identification guidelines was completed (refer Table 4-3). This assessment was based on the results of the sampled plot with the greatest native diversity and cover for each patch.

Some of the small remnants of woodland and scattered trees (e.g. Patch 3) assessed were in poor condition with little or no native shrub or groundcover species, or were dominated by exotic species (pasture improvement species and weeds). However, all of the patches sampled contained areas with some native groundcover species and potential for regeneration. Patch 1, 5 and 6 have a condition class of 2 in that they have a partially cleared/thinned canopy with a mixture of native and exotic understorey species. Patch 2, 3 and 4 have the lowest condition class (5), but are still considered part of the Endangered Ecological Community.

Table 4-3 Summary table of TSC Act Condition Criteria for determination of White Box, Yellow Box, Blakely's Red Gum Woodlands for each patch

TSC Act Condition Criteria for determining White Box, Yellow Box, Blakely's Red Gum Woodland	General Comment	Patch Number					
		1	2	3	4	5	6
Multi-aged overstorey with a grassy, herb-rich understorey (Condition class 1)	Remnants in this condition are very scarce and are generally confined to travelling stock reserves, roadside vegetation, cemeteries, some national parks and the occasional private property.	No	No	No	No	No	No
Partially cleared/thinned stands with a mixture of native and exotic understorey species (Condition class 2)	This condition is far more common than the above; however, its long-term future is often insecure due to inadequate regeneration of overstorey species. Often current management (e.g. set-stocking) is inconsistent with tree regeneration.	**Yes**	No	No	No	**Yes**	**Yes**
Stands where White Box, Yellow Box or Blakely's Red Gum have been killed and other species dominate the canopy (Condition class 3)	This condition occurs in woodlands where the characteristic trees occur in conjunction with White Cypress Pine. The understorey is often in reasonable to very good condition.	No	No	No	No	No	No
Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box-Gum Woodland understorey is present (Condition class 4)	This condition is likely to be reasonably common in some areas and is likely to be relatively easy to rehabilitate if appropriate management strategies are implemented.	No	No	No	No	No	No
Degraded remnants that have few, if any, native species in the understorey: (Condition class 5)	This condition is typical of Box-Gum Woodland where agricultural practices have been more intensive (e.g. pasture improvement over long periods).	No	**Yes**	**Yes**	**Yes**	No	No
Does patch meet one of the 5 condition criteria for classification of the vegetation as the listed community? (condition class)		Yes (class 2)	Yes (class 5)	Yes (class 5)	Yes (class 5)	Yes (class 2)	Yes (class 2)
Does patch meet requirements of the final determination for this community?		Yes	Yes	Yes	Yes	Yes	Yes

4.2.3 Inland Grey Box woodland

Inland Grey Box woodland is listed as an Endangered Ecological Community under the *Threatened Species Conservation Act 1995*.

The final determination for Inland Grey Box woodland under the *Threatened Species Conservation Act 1995* is broad, with gradients in floristic diversity found across its range. Inland Grey Box Woodland can, in some regions, be differentiated from *E. albens-E. melliodora* communities by grass species. *Themeda australis* and *Poa sieberiana* characterise the latter community whereas *Austrostipa scabra, Austrodanthonia* spp. and *Enteropogon* spp. are more typically associated with *E. microcarpa*, although disturbance weakens this correlation (NSW Scientific Committee 2007a).

This community may occur as treeless grasslands with '*Some remnants of the community survive with trees partly or wholly removed'* (NSW Scientific Committee 2007a).

Conversely, this community is also often restricted to remnants with trees largely intact but with the shrub or ground layers degraded to varying degrees through grazing or pasture modification.

Given the high number of disturbances commonly affecting this community, '*Disturbed remnants are considered to form part of the community including remnants where the understorey, overstorey or both would, under appropriate management, respond to assisted natural regeneration from the soil seed bank*' (NSW Scientific Committee 2007a).

Two of the vegetation communities within the study area, are consistent with the final determination for this community:

- Inland Grey Box tall grassy woodland.
- Derived Native Grassland.

Some of the small remnants of woodland and scattered trees (e.g. paddock patches within the north of study area — refer Figure 3-6) assessed were in poor condition with little or no native shrub or groundcover species, or were dominated by exotic species (pasture improvement species and weeds). However, all of the patches sampled contained areas with some native groundcover species and potential for regeneration. In general, the roadside reserves contained the highest quality condition patches. While the derived native grassland area was significantly cleared of its canopy in the past, the understorey within these areas contained a diverse assemblage of groundcover species and was still considered part of the Endangered Ecological Community.

4.2.4 Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment

The Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment is listed as an Endangered Ecological Community under the *Fisheries Management Act 1994* (NSW Fisheries 2002).

The Lower Murray ecological community includes all native fish and aquatic invertebrates within all natural creeks, rivers, and associated lagoons, billabongs and lakes of the regulated portions of the Murray River below the Hume Weir, the Murrumbidgee River below the Burrinjuck Dam, and the Tumut River below the Blowering Dam, as well as all of their tributaries and branches (NSW Fisheries 2002).

Tarcutta creek and Keijura creek flow into the Murrumbidgee River below the Burrinjuck Dam, and therefore, form part of this community.

4.2.5 Endangered populations

The study area occurs within the Wagga Wagga local government area. Within the Wagga Wagga local government area, the Squirrel Glider is listed as an Endangered Population under the *Threatened Species Conservation Act 1995* (NSW Scientific Committee 2000).

The Squirrel Glider, recorded during current field surveys, was observed using Box-Gum Woodland habitat at survey site S3 in the southern portion of the study area (Southern Travelling Stock Reserve).

4.2.6 Threatened species

Threatened plants

Eleven Threatened species of plant listed under the *Threatened Species Conservation Act 1995* were recorded previously, or are predicted to occur, within the locality (refer Appendix C). No threatened species of plant was identified in the study areas during the current field survey.

Three species are considered to have a Moderate Likelihood of occurrence based on suitable habitat within the study area and cryptic seasonal survey requirements: *Diuris tricolor*, *Ammobium craspedioides* and *Amphibromus fluitans* (refer Appendix C).

One of these species of plant, *Diuris tricolor,* is a cryptic flowering orchid that requires targeted survey during its flowering season for detection. Given that the current field surveys were completed outside of this specific flowering season a precautionary approach was taken based on potential habitat.

An assessment of the likely significance of impacts on these species has been considered in Chapter 7 and Appendix E.

Threatened animals

Thirty-six Threatened fauna species, as listed under the *Threatened Species Conservation Act 1995* or the *Fisheries Management Act 1994* have been recorded, are predicted to occur or have habitat in the locality (10 kilometre radius) of the study area or have been predicted to occur based on habitat assessments undertaken during recent field surveys and database searches carried out at the sub-catchment level (Murrumbidgee Catchment Management Authority, Lower Slopes Sub-Catchment). This comprised two species of amphibian, three species of reptile, 21 species of bird, six species of mammal and four species of fish (refer Table 4-4). Details of these species are provided in Appendix D.

Table 4-4 Threatened species of animal recorded or predicted to occur within the Proposal locality based on database search results

Group	Number of species
Amphibians	2
Birds	21
Mammals	6
Reptiles	3
Fish	4
TOTAL	**36**

Six Threatened species were recorded as part of the current field surveys. The Brown Treecreeper (eastern subspecies) was recorded in Box-Gum and Riparian Woodland across the study area, while the Speckled Warbler (observed in drainage line) and Barking Owl were recorded in Box-Gum Woodland at survey site S3. The Squirrel Glider was recorded in Box Gum Woodland at survey site S3, while the Eastern False Pipistrelle was recorded in Riparian Woodland in the study area. The Southern Pygmy Perch was recorded in Tarcutta Creek.

It is not likely, however, that all 36 species would be affected by the Proposal (refer Appendix D). Sixteen Threatened species are considered to have a low likelihood of occurrence based on the availability of habitats (refer Appendix D). Full details of species requirements and reasons for not considering impacts of the Proposal further are provided in Appendix D.

Significance assessments required under the *Environmental Planning and Assessment Act 1979* were completed for the remaining twenty species (refer Chapter 7 and Appendix E).

4.3 Regionally listed species and communities

4.3.1 Regionally rare communities

River Red Gum very tall open forest of the NSW South-western Slopes Bioregion is estimated as having an 85 per cent reduction in its pre European distribution due to clearing (Benson 2008) and is classified as an over-cleared vegetation type by Biometric (version 2.0) (NSW Department of Environment and Conservation 2005), within the Murray catchment.

4.3.2 Regionally rare species

No regionally rare species was recorded in the study area.

5. Potential impacts

This chapter describes the potential impacts of the Proposal on the biological environment, including loss of vegetation and habitats and impacts on Threatened species.

5.1 Loss of vegetation/habitats

The most significant impact of the Proposal would be loss of native vegetation and associated habitats. The Proposal would result in the loss of native vegetation within the subject site (as summarised in Table 5-1) including 16 hectares of native vegetation. This includes 12 hectares of Endangered Ecological Communities (Box-Gum Woodland and Inland Grey Box) as listed under the *Threatened Species Conservation Act 1995* and six hectares of Critically Endangered Ecological Community as listed under the *Environment Protection and Biodiversity Conservation Act 1999.*

Table 5-1 Potential loss of vegetation and habitat within study area

Vegetation communities	Tarcutta study area			Extent remaining in south-eastern NSW (hectares) [3]
	Area occupied within study area (hectares)	Area occurring within subject site	% removal from study area	
Blakely's Red Gum - Yellow Box grassy woodland*	25.7	6	23.3%	7,053
Apple Box grass-forb open forest*	2.0	1	50.0%	As above
Inland Grey Box tall grassy woodland*	12.5	4	32%	As above
Mugga Ironbark - Scribbly Gum - Red Gum open forest	3.1	0	0	486
Red Stringybark - Blakely's Red Gum open forest	3.3	0	0	36,146
River Red Gum very tall open forest of the NSW South Western Slopes Bioregion	35.3	4	11.3%	1,589
Derived Native Grassland* (Inland Grey Box Woodland)	12.0	1	8.3%	-
Total	**92.9**	**16**	**17%**	**45,272**
EEC[1] Box-Gum Woodland EPBC Act (exclude poor condition)	**26.0**	**6**	**23%**	**7,053**
EEC[1] Box-Gum Woodland TSC Act (all conditions)	**27.7**	**7**	**25%**	**7,053**

Vegetation communities	Tarcutta study area			Extent remaining in south-eastern NSW (hectares) [3]
	Area occupied within study area (hectares)	Area occurring within subject site	% removal from study area	
EEC[2] Inland Grey Box Woodland EPBC & TSC Act	**24.5**	**5**	**20%**	**7,053**
Fauna habitats				
Riparian Woodland	35.3	4	11%	
Box-Gum Woodland	46.6	11	23%	
Native Grassland	12.0	1	8%	

Notes: * forms part of an endangered ecological community, 1 - Box Gum Woodland, Endangered Ecological Community as listed under the *Environment Protection and Biodiversity Conservation Act 1999*. 2 – Inland Grey Box, Endangered Ecological Community as listed under the *Threatened Species Conservation Act 1995* 3 – Based on Thomas et al. (2000).

Clearing of native vegetation is listed as a Key Threatening Process under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*.

While the Proposal corridor generally traverses a modified agricultural landscape, significant areas of roadside vegetation, areas of the Southern Travelling Stock Reserve and areas of the Riparian Woodland and remnant Box Woodland would be affected. The Proposal would require the removal of approximately 16 hectares of remnant native vegetation/fauna habitat along the alignment, which effectively removes 17 per cent of vegetation within the study area. While the amount of clearing is small in relation to the extent of these communities in south-eastern NSW (refer Table 5-1), locally it is still important, particularly as it is estimated that less than 50 per cent of the Murrumbidgee catchment's native woodland vegetation remains (Miles & Trust 2001).

Within the study area, the Proposal would reduce the extent of vegetation cover from 20 to 16 per cent. While the value is still above the 10 per cent threshold suggested by Bennett and Radford (2004) for woodland birds, it would mean that the vegetation cover would remain below the 30 per cent level above which Reid (2000) suggested that most organisms and ecological processes characteristic of that ecosystem persist.

Vegetation would be removed along much of the northern and southern portions of the Proposal, particularly within those areas associated with diversions from the existing Hume Highway around Tarcutta (Riparian Woodland), and remnant patches associated with survey site S1 and S3. The total (cumulative) length of clearing is approximately seven kilometres. This vegetation clearing would be spread over all identified remnant patches of vegetation within the study area.

5.2 Habitat fragmentation and barrier effects

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with the occurrence of a new habitat type in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the species remaining within the fragments (Bennett 1990, 1993; Johnson *et al.* 2007). Although the newly created habitat is generally used by some species, those species are usually generalists and are often considered aggressive (e.g Noisy Miners Grey *et al.* 1998), further decreasing population levels of the species remaining in the fragments. Habitat fragmentation can result in a number of impacts including:

- **Barrier effects:** Barrier effects occur where particular species are either unable, or are unwilling, to move between suitable areas of fragmented habitat. This could result in either a complete halt to movement or a reduced level of movement between fragments. Species most vulnerable to barrier effects include rare species (even a small reduction in movements can reduce genetic continuity within the population, hence reducing the effective population size), smaller ground-dwelling species and species with low mobility. Species least vulnerable to barrier effects tend to be those that are highly mobile (e.g. birds and bats), although even these species can vary in their response to barriers.
- **Genetic isolation**: Genetic isolation occurs where individuals from a population within one fragment are unable to interbreed with individuals from populations in adjoining fragments. Genetic isolation can lead to inbreeding and genetic drift problems for populations isolated within a fragment.
- **Edge effects:** Edge effects are where a zone of changed environmental conditions (i.e. altered light levels, wind speed and/or temperatures) occurs along the edges of habitat fragments (refer Section 5.3).

The construction and operation of the Proposal would further fragment habitat and increase the isolation of remnant vegetation. With the Proposal alignment traversing travelling stock reserves, roadside vegetation and modified agricultural landscapes, the Proposal (nominal 50 to 100 metre corridor) would present a barrier within the landscape (in an east-west direction), particularly within the Tarcutta Creek riparian corridor and remnant patches within the Southern Travelling Stock Reserve (fauna survey site S3).

These areas have been significant disturbed by a history of agricultural land uses and the existing Hume highway. Given these disturbances the majority of species likely to be using these disrupted corridors are the highly mobile species, such as birds and bats primarily as marginal foraging habitats within a greater foraging range.

Barrier effects would increase for some species and in some areas may effectively isolate remaining vegetation on either side of the road. This would particularly be the case for small and sedentary fauna, such as ground-dwelling/arboreal mammals, reptiles and amphibians. However, more mobile species, such as birds and bats, may not be as affected by the barrier.

With the Murrumbidgee catchment being an important and diverse area of primary production in Australia, it is of no surprise that less than 50 per cent of the catchment's native woodland vegetation remains (Miles & Trust 2001). Therefore, vegetation currently occurring along the Proposal alignment, although moderately to highly disturbed, is likely to play a key role in the wider corridor network. The Proposal would increase the level fragmentation and isolation of some patches of vegetation in an east-west direction.

A study of the effects of clearing and habitat fragmentation on Threatened Squirrel Gliders in the Wyong local government area (Smith 2002a) classified remnant isolation as follows (refer Figure 5-1):

- Class 1 — remnants connected to other remnants by a narrow corridor (up to 250 metres wide.
- Class 2 — remnants separated from other remnants by a cleared gap (e.g. road or clearing) up to 100 metres wide, but with a broad area of contact, including native vegetation on both sides of the gaps for a width of at least 250 metres.
- Class 3 — as in Class 2 (above), but with a narrow width of contact (less than 250 metres wide).
- Class 4 — remnants separated from other remnants by cleared areas of 100–400 metres in rural environments or 100–200 metres in urban environments.
- Class 5 — remnants separated by more than 200 metres of urban habitat or 400 metres of cleared habitat.

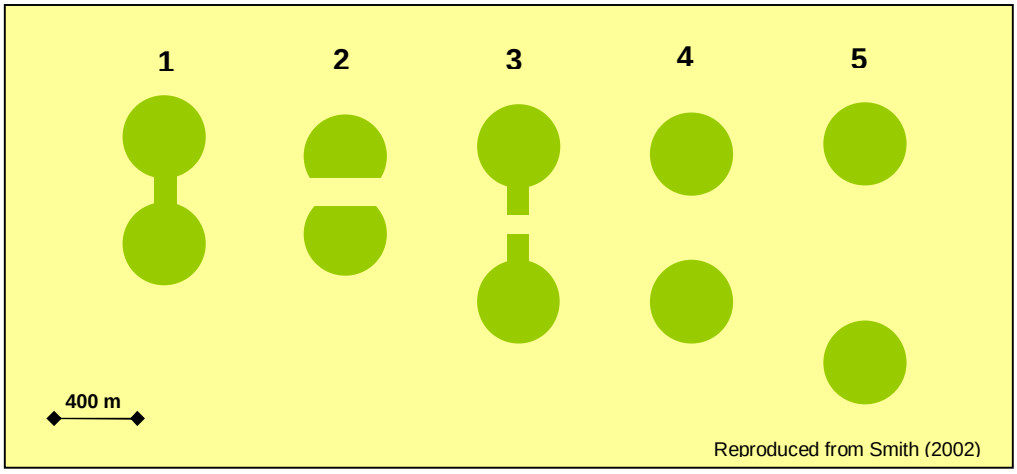


Figure 5-1 Remnant isolation classes

Vegetation in the study area is already fragmented by infrastructure, including roads (e.g. the existing Hume Highway), urban development and land clearing for agricultural purposes. Following the definitions outlined by Smith (2002), isolation of vegetation communities as a result of the Proposal would largely fall into Class 2 (refer Figure 5-1).

The Threatened Squirrel Glider was recorded during recent field surveys at survey site S3. Box-Gum Woodland habitat at survey site S3 essentially provided year-round foraging resources with *E. albens* flowering during winter, *E. melliodora* flowering during summer, *E. blakelyi* flowering during autumn and spring, and *E. sideroxylon* flowering during spring. Box-Gum Woodland habitat at survey site S3 provided good condition fauna habitat with a

relatively full suite of resources available to species such as the Squirrel Glider. While good condition habitat was not recorded along other sections of the Proposal alignment, it is likely that Squirrel Glider would potentially use some of the habitat trees and food resources, recorded along the alignment, as Squirrel Gliders are often found in remnant and roadside patches of eucalypt woodland (van der Ree 2008).

Recent studies comparing movements of Squirrel Gliders across a single carriageway highway in Victoria with a section of dual carriage highway nearby, suggests that individuals are far less likely to cross the wider road (van der Ree 2006). This work suggests that the difference is likely due to a combination of the width of the road, the volume of traffic and the speeds of the traffic. Squirrel Gliders can glide for more than 50 metres (NSW National Parks and Wildlife Service 1999); however; average glides are generally 20 metres (Jackson 1999). As such, the construction and operation of a dual carriageway bypass is likely to create a barrier to their movement.

5.3 Edge effects

Edge effects are zones of changed environmental conditions (i.e. altered light levels, wind speed and/or temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators. Edge effects have mainly been recorded adjacent to roads and at distances greater than 1,000 metres from the road surface (Forman *et al.* 2000). However, Bali (2000), in a comparison of edge effects in a variety of different habitat types, estimated that average edge effects generally occur up to 50 metres away from the road edge.

The majority of vegetation within the study area occurs within relatively small, fragmented patches, many of which are subject to past and present disturbance regimes (e.g. grazing) and hence, already consist of edge-affected habitats. Using the estimate of 50 metres proposed by Bali (2005), it is likely that new edge effects would be introduced in the larger remnants of vegetation, such as survey site S2 and S3. The changes to habitat resulting from the introduction of edge effects into the previously ‘core’ areas of these remnants is likely to be approximately six hectares.

A change in the microhabitat conditions in remnant vegetation patches as a result of vegetation clearing and earthworks increases the likelihood of the germination and establishment of exotic plants (weeds). The germination and establishment of weeds is most likely to occur in areas affected by vegetation clearing, in areas of exposed soil/fill (such as topsoil stockpiles, soil cuttings, fill batters and scree slopes) and along edge-affected areas of remnant vegetation, particularly those linear remnants along existing Hume highway to the north and south of the town of Tarcutta. However, field surveys within these remnant patches identified significant disturbances associated with edge effects from grazing and adjoining agricultural land practices. It is considered that any marginal increase in these effects caused by the Proposal is unlikely to be significant.

5.4 Vehicle strike and direct mortality

Fauna injury or death could occur as a result of the Proposal's construction phase, when vegetation and habitats are being cleared. They also have the potential to occur during the operation of the bypass as a result of collision with vehicles.

While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile, or those that are nocturnal and restricted to tree hollows, may have difficulty moving over relatively large distances. Threatened species that may be affected by vegetation clearing include microchiropteran bats and Squirrel Gliders. The RTA has policies and guidelines in place that outline procedures to prevent fauna mortality during construction.

While the Proposal would result in a road corridor traversing a relatively modified landscape, this would result in a wide area of road for animals to cross and negotiate, which would increase the extent of vehicle strikes. Threatened fauna that may be affected by vehicle strikes include the Squirrel Glider (Claridge & van der Ree 2004), the Swift Parrot (Swift Parrot Recovery Team 2001) and woodland species of bird such as the Grey-crowned Babbler (Davidson & Robinson 1992; Robinson *et al.* 2001).

It is likely that the Proposal will have the greatest impacts on these species in the south of the study area, where the alignment traverses between existing remnant roadside vegetation and the Southern Travelling Stock Reserve.

5.5 Weeds

Ninety-three species of weed were observed within the study area. Amongst these were seven species of noxious weed listed under the *Noxious Weed Act 1993* (refer Table 3-9).

The distribution of these exotic weed infestations across the study area can generally be split into the following broad distributional areas;

Riparian areas associated with the River Red Gum Open Forest vegetation community contained dense thickets of *Salix babylonica* along the creek banks. While the groundcover on the creek banks and floodplains was dominated by exotic rushes and sedges and pasture improvement species and weeds, including *Echium plantagineum, Hordeum leporinum, Vulpia myuros, Lythrum hyssopifolia, Lolium perenne, Phalaris aquatica* and *Bromus* spp.

The isolated pocket of the Derived Native Grassland and adjoining Inland Grey Box Woodland vegetation communities to the northwest of the town of Tarcutta, the road side remnants north of the town of Tarcutta and the remnant vegetation communities within the Southern Travelling Stock Reserve all contained relatively low densities of exotic 'pasture improvement' species used to improve soil conditions and/or provide feed for grazing stock in the adjoining pastures. The most abundant exotic species within these areas were *Bromus* spp., *Hordeum leporinum, Lolium spp., Echium plantagineum, Avena fatua, Hypochoeris radicata* and *Romulea rosea.*

The remaining paddock remnants of natural vegetation communities and the road side remnants south of the town of Tarcutta, were heavily infested by a variety of exotic 'pasture improvement' species used to improve soil conditions and/or provide feed for grazing. The most abundant exotic species within these areas were *Bromus spp., Plantago lanceolata, Medicago polymorpha, Phalaris aquatica, Silybum marianum, Lolium spp., Echium plantagineum, Avena fatua, Trifolium spp.* and *Romulea rosea.*

The construction of the Proposal has the potential to disperse weeds into areas of remnant vegetation where weed species do not currently occur. The most likely causes of weed dispersal associated with the Proposal would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery. This may, in turn, reduce the habitat quality of the sites for Threatened species, such as woodland species of bird (Robinson *et al.* 2001) .The majority of the vegetation within the study area, however, already has considerable weed growth; therefore, the overall extent of habitat modification is not likely to increase significantly. Spread of weeds during the operation of the Proposal would relate generally to maintenance activities.

5.6 Changed hydrology

Waterway crossings could modify the natural hydrology of creeks within the study area, which could ultimately affect the aquatic assemblages that use these areas (Fairfull & Witheridge 2003). Impacts from waterway crossings may include:

- Excessive flow velocities, which could erode creek banks and lead to changes in water quality, as well as acting as a barrier to any fish movements in the creek.
- Modified water depths of the creek, which could act as a barrier to fish movement and cause loss of interconnectivity between pools.
- Increased water turbulence, which could lead to the avoidance of the area by various aquatic organisms.

Waterways to be crossed by the Proposal include Keajura Creek and Tarcutta Creek. Changes in hydrology are discussed in Technical Paper 4 – Hydrology and Hydraulics.

5.7 Aquatic disturbance and impacts on fish passage

The construction of the Proposal would require the crossing of Tarcutta Creek and Keajura Creek. Indirect impacts would be associated with these crossings. A large farm dam located in the north of the study area would effectively be removed, resulting in a direct impact on this aquatic habitat.

Twin bridges proposed to expand across Tarcutta Creek (and Tarcutta Creek Floodplain) and Keajura Creek would alter creek bed characteristics and, depending on bridge design, would have implications for the sediment loading of the creek. For example, sediment may accumulate around the bridge structure due to the change in flow behaviour, or, scouring may occur around the bridge increasing the sediment loading of the waterway.

Barriers to fish passage from the installation of waterway crossings (including bridges and culverts) can occur temporarily (i.e. during construction) and/or over the long term if inappropriate structures are used. Several species of fish occur in the two study areas that need to move between habitats for a variety of reasons, including the search for food and shelter, dispersal into available habitat and reproduction. In addition to potential impacts from alteration of natural hydrology at waterway crossings (refer Section 5.6), other impacts, such as decreased light levels and debris blockage, have the potential to affect fish passage (Fairfull & Witheridge 2003).

Tarcutta and Keajura creeks currently have disrupted fish passages due to waterway crossing. These crossings include an existing box culvert associated with the Hume highway crossing of Keajura creek, a bridge pillar bridge, associated with the Hume highway crossing of Tarcutta creek.

During construction, run-off from disturbed surfaces would potentially affect water quality in local creeks due to sedimentation. In addition, there is the potential for accidental spillage/leakage of road construction materials, fuels, lubricants and hydraulic oils from construction equipment.

During operation, the paved surface of the Proposal would result in an increase in stormwater run-off volumes and flows. This could potentially increase flood levels and velocities in drainage lines downstream of the highway, although this is unlikely to be significant.

Fish and mobile invertebrate assemblages of the water bodies sampled during this study were fairly typical of freshwater habitats within the region and the fish assemblage consisted of introduced species. Therefore, it is unlikely that any unique fish assemblages would be significantly affected by the proposed waterway crossings themselves. Given that suitable habitat exists upstream and downstream of the Proposal, no long-term impacts from the proposed waterway crossings would be expected for fish and mobile invertebrate assemblages within the area.

5.8 Potential impacts on groundwater dependent ecosystems

Groundwater dependent ecosystems are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation 2002). When considering groundwater dependent ecosystems, groundwater is generally defined as the saturated zone of the regolith (the layer of loose rock resting on bedrock, constituting the surface of most land) and its associated capillary fringe; however, it excludes soil water held under tension in soil pore spaces (the unsaturated zone or vadose zone) (Eamus *et al.* 2006).

Groundwater dependent ecosystems include a diverse range of ecosystems as shown in Figure 5-2.

Eamus *et al*. (2006) considers the following broad classes of ecosystems as having complete or partial groundwater dependency:

- Aquifer and cave ecosystems, where stygofauna (groundwater-inhabiting organisms) may reside within the groundwater resource. The hyporheic zones (refer Ecosystem 5 in Figure 5-2) of rivers and floodplains are also included in this category because these ecotones often support stygobites (obligate groundwater inhabitants).
- All ecosystems dependent on the surface expression of groundwater. This category includes base-flow rivers and streams, wetlands (refer Ecosystems 2 and 3 in Figure 5-2), some floodplains and mound springs and estuarine seagrass beds. While it is acknowledged that plant roots are generally below ground, this class of groundwater dependent ecosystem requires a surface expression of groundwater, which may, in many cases, then soak below the soil surface and thereby become available to plant roots.

- All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the saturated zone of the water table) when roots penetrate this zone. This class includes terrestrial ecosystems such as River Red Gum (*E. camaldulensis*) forests on the Murray–Darling basin (refer Ecosystems 1 and 4 in Figure 5-2). No surface expression of groundwater is required in this class of groundwater dependent ecosystems.

The term 'groundwater dependent ecosystem' refers to ecosystems ranging from those entirely dependent on groundwater to those that may use groundwater while not having a dependency on it for survival (i.e. ecosystems or organisms that use groundwater opportunistic or as a supplementary source of water) (Hatton & Evans 1998).

Groundwater dependent ecosystems possess a range of values, including being important and sometimes rare ecosystems in themselves, as well as providing important ecosystem services such as water purification (Department of Land and Water Conservation 2002). Groundwater is also an increasingly important resource for human uses in Australia (there was a 90 per cent increase in groundwater extraction between 1985 and 1997 (National Land and Water Resources Audit 2001). Nationally groundwater is extracted for uses including irrigation (48 per cent), urban and industrial use (33 per cent) and stock watering and rural use (19 per cent) (Department of Land and Water Conservation 2002; Eamus *et al.* 2006; Murray *et al.* 2003; PPK Environment & Infrastructure 1999; Sinclair Knight Mertz 2001)

The potential for groundwater extraction to exceed recharge has resulted in awareness of the effects of groundwater availability or regimes that may result in adverse impacts to groundwater dependent ecosystems (Department of the Environment and Heritage 2001), and thereby threaten the values they provide.

Within the study area there are two main flow systems present — fractured rock and alluvial aquifers. The unconsolidated alluvial aquifer is relatively close to the surface at 1 to 12 metres below the surface, with the fractured rock much deeper (greater than 40 metres deep). Much of the vegetation within the study area is likely to access groundwater resources. However, given the broad regional distribution of these communities and the varied topography over which they occur, it is unlikely that they will be dependent on the groundwater resources. The exception is the River Red Gums and other riparian vegetation that may show a proportional dependence on the groundwater.

The Proposal would require the excavation and shaping of the upper soil profile and minor alterations to the existing surface water drainage however is unlikely to require groundwater extraction or significant impacts on the existing subsurface aquifers and their associated groundwater dependent ecosystems.

Table 5-2 Vegetation community dependency on groundwater

Ecosystem type[1]	Vegetation communities[2]	Possible groundwater dependency[2]
Terrestrial ecosystem	Blakely's Red Gum - Yellow Box grassy woodland	No apparent dependency on groundwater
	Apple Box grass-forb open forest	No apparent dependency on groundwater
	Mugga Ironbark - Scribbly Gum - red gum graminoid open forest	No apparent dependency on groundwater

Ecosystem type[1]	Vegetation communities[2]	Possible groundwater dependency[2]
	Red Stringybark - Red Box - Long-leaved Box - Scribbly Gum open forest	No apparent dependency on groundwater
	Inland Grey Box tall grassy woodland	No apparent dependency on groundwater
	Derived Native Grassland	No apparent dependency on groundwater
River base flow	River Red Gum very tall open forest of the NSW South Western Slopes Bioregion	Proportional dependence on groundwater
	Riparian Vegetation (ephemeral)	Groundwater accessed opportunistically or to a very limited extent
Other ecosystems	-	-

Notes: 1- Ecosystem Types as per Murray et al (2003) ; 2 - Groundwater dependency as per Hatton & Evans (1998)

5.9 Cumulative impacts

The potential biodiversity impacts of the Proposal have been considered as a consequence of the construction and operation of the Proposal within the existing environment. The incremental effect of multiple sources of impact (past, present and future) are referred to as cumulative impacts (Contant & Wiggins 1991; Council on Environmental Quality 1978) and provide an opportunity to consider the Proposal within a strategic context. This is necessary so that impacts associated with the Proposal and other activities within the region are examined collectively.

Due to its location in general agricultural lands, the Hume Highway Tarcutta bypass and previously assessed Hume highway duplications to the north and south of the Proposal are the primary developments within the local area. The construction and development of the Hume Highway duplication to the north and south of the Proposal have previously been considered separately (Parsons Brinckerhoff 2007; SKM 2007). This report has considered the impacts from the Hume Highway Tarcutta bypass.

The biodiversity impacts of the Proposal considered in this report are likely to be more significant as a result of biodiversity impacts from the previous surrounding Hume Highway duplication proposals (refer Table 5-3). These cumulative impacts would include a greater extent of clearing of native vegetation and habitats, including Endangered Ecological Communities, as well as further fragmentation of habitats. It is estimated that a total of approximately 125 hectares of native vegetation has been or will be cleared for the current eight projects of the upgrade of the Hume Highway. The current proposal will contribute 14% of this clearing. The total extent includes 93.03 hectares of Endangered Ecological Community, of which the current Proposal contributes 12 hectares.

Table 5-3 Extent of vegetation clearing for the current Hume Highway duplication and bypass projects

Section of upgrade	Extent of vegetation clearing (ha)	Extent of EEC[1]
N1 Tarcutta duplication	9.17	4.22
N2 – Kyeamba dulpication	27.23	21.8
N3 – Little Billabong duplication	18.9	13.0
N4 – Yarra Yarra duplication	15.12	14.53
Woomargama duplication	13.55	7.48
Holbrook Bypass [2]	20	19
Woomargama Bypass [2]	4	1
Tarcutta Bypass (this Project)	16	12
TOTAL	**123.97**	**93.03**

Note: 1 – includes all Endangered Ecological Communities. 2 – Estimates based on preliminary concept designs.

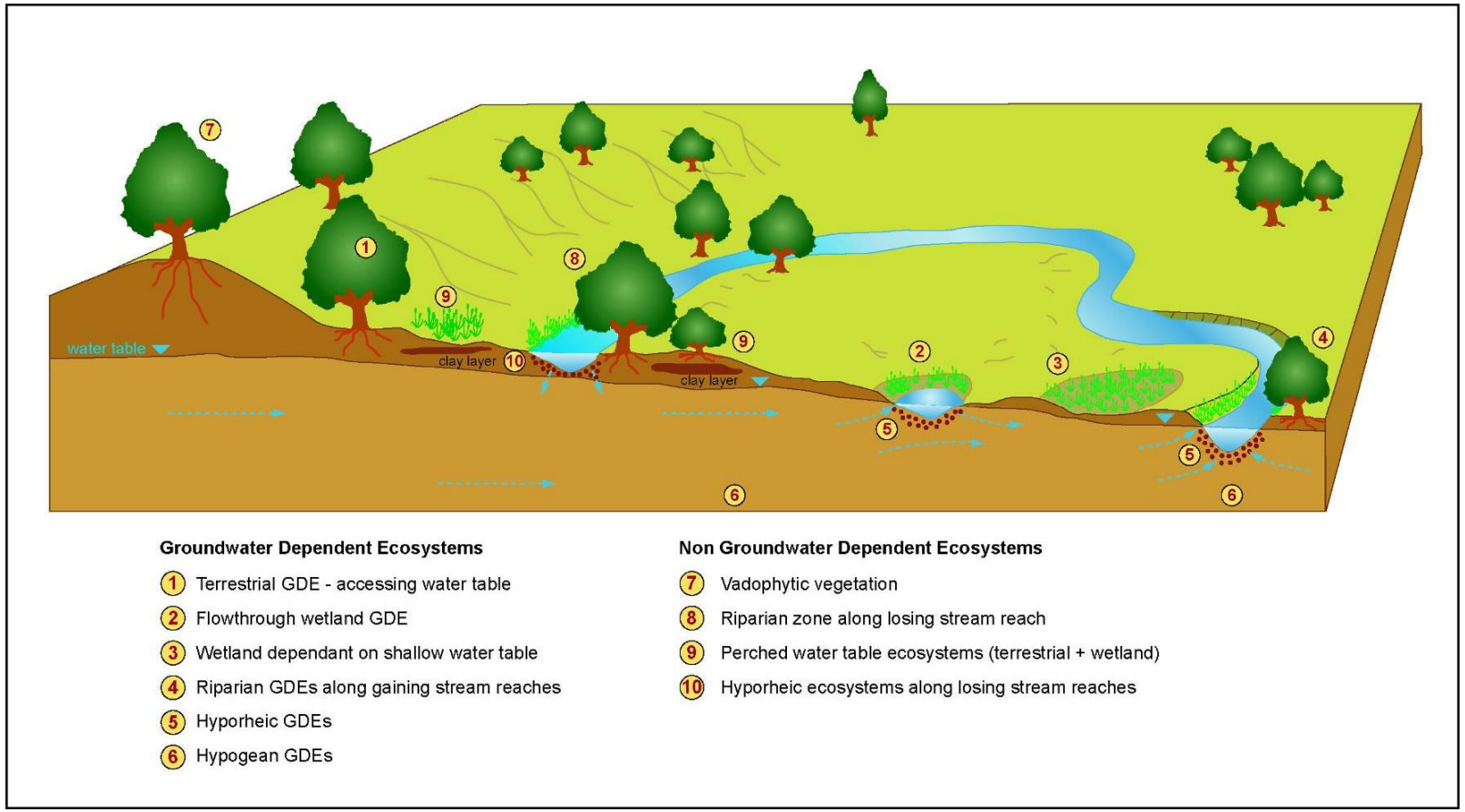


Figure 5-2 Conceptual biophysical model of groundwater dependent ecosystems

6. Proposed design features and mitigation measures

6.1 RTA policy

RTA policy regarding road developments and their associated impacts on habitat includes the general principle that the planning and construction of roads should, in order of consideration, endeavour to:

- Avoid impacts on habitat, through the planning process.
- Minimise impacts on habitat, through the planning process.
- Mitigate impacts on habitat, through the use of a range of mitigation measures.

The avoidance of impacts can be achieved through the planning and route selection process. The route selection process involved a preliminary examination of a number of possible route options and their potential impacts on the environment and other factors (for example, economic and social considerations). Those potential routes that best fit the environmental, social and economic criteria are then short-listed.

Minimising impacts involves reducing the loss of habitat or significant species as far as practicable. Short-listed routes are generally loosely defined within a broad corridor. Through surveys within these corridors, it is usually possible to fine-tune the final alignment and the width of the footprint to minimise loss of important vegetation communities or habitats and avoid significant plant species or habitat features. The final alignment and footprint are also subject to engineering constraints and RTA safety standards.

Residual impacts that cannot be avoided or minimised are mitigated, wherever possible. Depending on vegetation and project type, mitigation measures generally employed during road construction can include the following:

- Construction of underpasses.
- Fauna exclusion fencing.
- Landscaping and revegetation.
- Site rehabilitation.

6.2 Route selection and early design changes

Three preliminary route options, being a western, eastern and central route option were initially considered for the location of the proposed bypass of Tarcutta. In June 2007, an options assessment workshop, involving the community and select government agencies, was held to review the results of the preliminary investigations. At the workshop, the RTA proposed to abandon the central route option through Tarcutta based on safety concerns, which was supported by community feedback and the workshop participants. The remaining two options, a bypass to the east or west of Tarcutta, were analysed based on preliminary environmental investigations subsequently undertaken for both bypass options (Parsons Brinckerhoff 2008).

Issues considered in the assessment included:

- Biodiversity.
- Aboriginal heritage.
- Non-Aboriginal heritage.
- Hydrology.
- Property access.
- Noise and vibration.
- Visual.
- Geology and soils.
- Contaminated land.
- Land use and property.

The results of these preliminary investigations were reviewed and presented in a value management workshop in February 2008. The workshop consisted of community members, representatives from government agencies, PB and the RTA.

The analysis indicated that,

- A preference for the western route was given due to the length being shorter than the eastern bypass option, and therefore, offered a better overall value-for-money solution than the eastern option.
- While both options would be constructed in accordance with the relevant safety standards, the western option was considered safer from a road user perspective as the alignment is straighter.
- The western option would require less property acquisition and would result in less severance impacts.
- Being closer to, and in viewing distance of, the village, the western option was considered to provide a better opportunity to reduce the socio-economic impacts of the bypass by providing easy access to the village from the highway to encourage the village's continued role as a highway service centre.
- The western option provides the opportunity for further reductions in environmental impacts, including biodiversity, cultural heritage and Aboriginal archaeology, during refinement of the design. In comparison, the main environmental concerns for the eastern option, such as the potential impacts on biodiversity in rocky outcrops and threatened woodlands and impacts to Aboriginal cultural areas, would be more difficult to mitigate.
- A recommendation of the western option as the preferred bypass option subject to addressing the recognised impacts on biodiversity, particularly Endangered Ecological Communities, and Aboriginal archaeology and cultural heritage.

In terms of biodiversity, the western option:

- Offers capacity to mitigate impacts on biodiversity through design, minimising footprint on sensitive areas.
  - Avoided potential habitat of the Pink-tailed Worm-lizard and Striped Legless Lizard.
  - Under the modified design can retain connectivity with travelling stock routes.

The western alignment was then modified to minimise environmental impacts. Modifications relating to biodiversity included moving the alignment further east in the south of the Proposal to avoid a significant area of remnant vegetation.

6.3 Management of the mitigation process

The impacts and mitigation associated with the Proposal are discussed below. Prior to the start of construction (i.e. essentially occurring as part of the detailed design), it is recommended that detailed mitigation measures be developed and presented in a biodiversity management plan relating to the construction and operation of the road. The biodiversity management plan should be reviewed and updated throughout the construction project in light of outcomes of the detailed design that cannot necessarily be realised prior to the commencement of construction. The plan should include, where appropriate, procedures for:

- Detailed design of mitigation measures such as fauna crossing points.
- Staff and contractor inductions to address the location of sensitive biodiversity and roles and responsibilities in the protection and/or minimisation of impacts to all native biodiversity.
- Pre-clearing surveys and fauna salvage/translocation where practical.
- Vegetation clearing protocols.
- Rehabilitation and restitution of adjoining habitat where possible.
- Weed control and notification of noxious weeds to the NSW Department of Lands.
- Pest management.
- Rehabilitation protocols.
- A flora and fauna monitoring program for the Proposal to better understand and manage impacts and rehabilitation actions for flora and fauna.

The plan should include clear objectives and actions for the Proposal including, where appropriate:

- Minimising human interferences to flora and fauna.
- Minimising vegetation clearing/disturbance.
- Minimising impact to threatened species and communities.
- Minimising impacts to aquatic habitats and species.
- Ongoing monitoring of impacts on flora and fauna.

This biodiversity management plan will be an important document for the environmental field supervisor or ecologist in enacting the 'avoid and mitigate' principles during the construction phase.

6.4 Mitigation measures

The mitigation measures described in this section are based on the likely impacts of the Proposal and follow the principle of avoid, minimise and mitigate. Mitigation measures are discussed in broad terms below and specific mitigation measures are presented in Section 6.4.5.

6.4.1 Vegetation and habitat loss

Disturbance to areas of native vegetation and habitat would be unavoidable during the construction process. However, in order to minimise clearing impacts and further disturbance, the limits of clearing should be clearly identified during the construction process. The limits of clearing should be marked clearly on plans and on the ground. Areas beyond the identified clearing areas should not be disturbed. Ancillary facilities such as stockpile sites, site compounds and construction zones should not be located beyond the limits of clearing. During the detailed design stage, opportunities to further minimise vegetation disturbance should be considered.

Where clearing of vegetation and fauna habitats will take place, clearing protocols should be put in place, including preparing an inventory of trees and hollows to be removed, checking hollow-bearing trees for the presence of bird nests and arboreal mammals, such as possums, gliders and bats, prior to felling. Animals found to be occupying trees should be safely removed before the clearing of trees and relocated into nearby woodlands. Nest boxes or salvaged tree hollows should be provided in nearby woodland and be proportional to the number of hollows removed during felling.

The landscape plan should be developed that integrates and complements the habitat values of the study area. The landscape plan should:

- Use locally occurring native shrubs, trees and groundcover plants.
- Include logs, dead trees and stumps in strategic locations to enhance fauna habitat.
- Incorporate existing natural vegetation where possible.
- Provide vegetative links to existing bushland remnants in the study area.
- Include measures to manage weeds through a weed management plan.

6.4.2 Fragmentation, terrestrial barrier effects and road mortality

The greatest barrier effects would result from the clearing of existing roadside vegetation, Riparian Woodland (survey site S2) and remnant stands of Box-Gum Woodland (survey site S1 and S3). As discussed above, consideration should be given in the design process to minimising vegetation clearing in these areas. This would maintain the overall width of the existing habitat corridor and maintain connectivity for a range of birds and mammals using this habitat as a movement corridor in a north-south direction.

Maintaining vegetation in areas with connecting roads (and roadside vegetation) or riparian areas is also important. In such areas, the road corridor itself may present a barrier to movement. Vegetation retained within the median would facilitate the movement of animals across the road by providing a 'stepping stone'.

The Proposal would include drainage structures, including box culverts and a bridge within the potential local wildlife corridor associated with Tarcutta creek and other creeklines dissecting the Proposal alignment. Generally, fauna underpasses work well for ground dwelling species. Monitoring of underpasses on the Pacific Highway has indicated that 20 native mammal species used the fauna underpasses (Australian Museum Business Services 2001a, 2001b, 2001c, 2001d). Species that were found to use the underpasses include a range of terrestrial mammals like dasyurids, macropods, rodents, bandicoots and bats, as well as reptiles and amphibians. Given that the drainage structures in the Proposal are likely to be dry for some of the year, they may potentially act as fauna underpasses for a range of ground-dwelling animals including amphibians, reptiles and mammals.

As part of the duplication projects for the Hume Highway upgrade it was suggested that crossing zones (of at least 100 metres) be used for Squirrel Gliders as opposed to crossing points (van der Ree 2008). These zones should have either extensive vegetation in the median or multiple gliding poles. Squirrel Gliders were recorded during the current surveys (survey site S3) and suitable habitat exists along the Proposal alignment. It is recommended that such crossing zones be included in the Proposal at survey site S3 (linking Riparian Woodland on the eastern side of the Proposal) as well as in Riparian Woodland associated with Tarcutta Creek (survey site S2).

NSW Department of Primary Industries (Fisheries) guidelines (Fairfull & Witheridge 2003) would be used when designing waterway crossings for the Proposal, so as to maintain the flow of all waterbodies within the study area. This would mitigate any impacts due to the potential loss of aquatic habitat, excessive waterflows, modified water depths and increased turbulence).

6.4.3 Aquatic disturbance and barrier effects

Little aquatic disturbance within the study area is expected once construction of waterway crossings is completed, provided that crossings are designed according to NSW Fisheries guidelines and damage to any aquatic habitat and riparian vegetation during construction is minimised (Fairfull & Witheridge 2003). Areas of riparian vegetation likely to be damaged or removed during construction should be replanted on completion of the works. In addition, appropriate erosion and sediment control measures should be put in place around all proposed waterway crossings prior to construction to ensure minimal change in water quality of the waterways due to run-off.

All waterway crossings should comply with NSW Department of Primary Industries (Fisheries) guidelines on fish passage requirement (Fairfull & Witheridge 2003). Minor drainage lines within the study area are classed as Class 3 Minimal Fish Habitat. As such, as a minimum they should include 'low flow' culvert design procedures. Tarcutta Creeks is classed as Class 1 and a bridge is required.

Best practice erosion and sediment controls should be implemented in accordance with Volume 2D of Managing Urban Stormwater: soils and construction (Department of Environment and Climate Change 2008c).

6.4.4 Monitoring

Monitoring the design and implementation of mitigation measures actions is important to ensure their effectiveness. Details of mitigation measures undertaken must be recorded along with any subsequent outcomes. Monitoring of the success or otherwise of mitigation measures could form part of the existing monitoring program for the Hume Highway Duplication involving woodland birds, squirrel gliders and fish. .

6.4.5 Detailed mitigation measures

Detailed mitigation measures for the Proposal are shown in Table 6-1. These are presented for both construction and operation of the Proposal.

Table 6-1 Detailed mitigation measures

Impact	Mitigation
Construction	
Vegetation and habitat loss	▪ Limit disturbance of vegetation to the minimum necessary to construct the road. ▪ Implement a two stage clearing protocol for all hollow-bearing tree clearing. ▪ Mark all hollow-bearing trees to be felled and catalogue their species and approximate dimensions so that hollows or nest boxes can be affixed to similar standing trees. ▪ Attach salvaged sections of hollows or nest boxes to trees in a way that allows for tree expansion and does not poison the tree. Hollows or nest boxes would be attached to trees with consideration of aspect, height and location appropriate for the target fauna species. The location of each relocated hollow or nest box would be recorded using GIS equipment during installation. ▪ Collect native seed prior to clearing, for use in the revegetation of disturbed areas. ▪ Landscaping would include: ‣ Planting of a range of native shrubs, trees and groundcover plants. ‣ Incorporation of existing natural vegetation where possible. ‣ Linking of bushland remnants. ‣ Maintenance of plantings through a landscaping plan. ▪ Mark the limits of clearing and install fencing around the construction footprint area prior to construction activities commencing to avoid unnecessary vegetation and habitat removal. ▪ Restrict equipment and stockpiling of resources to designated areas in cleared land to minimise the overall impact of the construction. ▪ Place transportable habitat features such as large logs and boulders, in adjacent retained areas where possible to allow their continuation as potential fauna refuge sites. ▪ Progressively revegetate disturbed areas. ▪ Locate sediment ponds in existing cleared areas where possible to minimise the loss of habitat.

Impact	Mitigation
Weeds	▪ Undertake ongoing management and monitoring of weed invasion through a weed management plan. ▪ A weed management plan would be developed to manage weeds during the construction phase.
Habitat fragmentation and barrier effects	▪ During design include crossing zones in the area of the southern reserve and Tarcutta Creek. ▪ Maintain fish passage at all times during the culvert extension and modification works.
Changed hydrology	▪ Design and construct waterway crossings in accordance with the DPI's *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull & Witheridge 2003). ▪ Prepare a progressive erosion and sediment control plan following best practice in accordance with Blue Book Volume 1 and Volume 2 Chapter 2D and RTA Policy. Design temporary scour protection and energy dissipation measures to protect receiving environment from erosion. ▪ Revegetate riparian zones affected by the Proposal with native species.
Success of mitigation	▪ Undertake monitoring in line with current monitoring programs on the Hume Highway.
Cumulative loss of habitat	▪ Offsets for residual biodiversity impacts would be guided by the Hume Highway Duplication Offset Strategy.
Operation	
Weeds	▪ Undertake ongoing management and monitoring of weed invasion for two years following completion of the bypass construction.
Vehicle strike and direct mortality	▪ Locate revegetation works to increase fauna habitat linkages. ▪ Design drainage structures to incorporate fauna movement. ▪ Reduce the median width to the minimum necessary for safe operation of the road in fauna crossing zones.
Changed hydrology	▪ Plant macrophytes along the stream banks to filter flow and enhance bank stability. ▪ All water discharge into streams would be guided by the ANZECC Water Quality Guidelines (2000).

6.4.6 Summary of mitigation measures

A summary of the mitigation measures proposed against the various potential impacts is presented in Table 6-2.

The summary indicates that although the mitigation measures are generally adequate for the impacts that are likely to occur, they are not sufficient with respect to the clearing of native vegetation. Although some vegetation may be retained in the alignment to reduce the extent of vegetation clearing, some vegetation clearing would still remain (including clearing of the Endangered Box Gum Woodlands and Inland Grey Box Woodland).

Table 6-2 Assessment matrix of mitigation measures

Mitigation measure	Vegetation clearing and habitat loss	Fragmentation and terrestrial barrier effects	Changed hydrology	Aquatic disturbance and barriers to fish passage
Retaining vegetation	✓	✓		
Delineating extent of vegetation clearing on ground	✓			
Putting in place vegetation clearing protocols including inspection of hollows	✓			
Revegetation (including habitats)	✓	✓		
Weed management	✓			
Including fish friendly waterway crossings			✓	✓
Prepare an erosion and sediment control plan			✓	✓
Flora and Fauna Management Subplan	✓	✓	✓	✓
Adequate mitigation?	**No**	**Yes**	**Yes**	**Yes**

6.5 Biodiversity offsets

Following consideration of the proposed mitigation measures (refer Table 6-1), it is concluded that impacts relating to the clearing of native vegetation and fauna habitats would not be sufficiently mitigated. Where there is residual loss or degradation of native vegetation after route selection, road design and implementation of mitigation measures, compensation in the form of biodiversity offsets may be employed.

The RTA commit to developing a biodiversity offset strategy with the objective of offsetting the residual impacts on biodiversity, particularly on threatened ecological communities and habitat for Threatened species so as to maintain or improve biodiversity values in the area in the long term.

The RTA has developed an offset strategy for the Hume Highway duplication projects (NSW Roads and Traffic Authority 2007). The document includes the methodology used to determine how the ecological values lost as a result of the Hume Highway duplication will be offset and provides a framework for the development and implementation of a biodiversity offsets package. Biodiversity offsets for the current Proposal, including both their calculation and implementation, could be guided by this document.

In determining the final biodiversity offsets strategy, consultation with the NSW Department of Environment and Climate Change and Australian Government's Department of the Environment, Water, Heritage and the Arts would be required.

7. Assessment of significance of impacts

This chapter summarises the assessment of significance of the potential impacts following the requirements of the *Environmental Planning and Assessment Act 1979* (draft *Guidelines for Threatened Species Assessment under Part 3A of the Environmental Planning and Assessment Act 1979*) and the *Environment Protection and Biodiversity Conservation Act 1999*

Projects assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* do not require assessments of significance under Section 5A of the Act (the Seven Part Test). Instead the assessment is based against heads of consideration detailed in the draft *Guidelines for Threatened Species Assessment*, indicating the significance of the impacts relative to the conservation importance of the habitat, individuals and populations likely to be affected.

Impacts are considered more significant if:

- Areas of high conservation value are affected.
- Individual animals and/or plants and/or subpopulations that are likely to be affected by a proposal play an important role in maintaining the long-term viability of the species, population or ecological community.
- Habitat features that are likely to be affected by a proposal play an important role in maintaining the long-term viability of the species, population or ecological community.
- The impacts are likely to be long-term in duration.
- Impacts are likely to be permanent and irreversible.

Threatened biodiversity listed under the *Environment Protection and Biodiversity Conservation Act 1999* were assessed following the *Principal Significant Impact Guidelines*. A referral under the *Environment Protection and Biodiversity Conservation Act 1999* has been completed for the Proposal.

Assessments were completed for Threatened biodiversity that were likely to occur within the study area, as listed in Table 7-1, including three Endangered Ecological Communities, three species of plant and 20 species of animal. Details of the assessments are presented in Appendix E.

Table 7-1 Summary of significance assessments completed

Threatened biodiversity	TSC Act[1]	FM Act[2]	EPBC Act[3]	Likely significant impact
Endangered Ecological Communities				
Box-Gum Woodland	E		CE	No
Inland Grey Box woodland	E		E*	No
Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment		E		No

Threatened biodiversity	TSC Act[1]	FM Act[2]	EPBC Act[3]	Likely significant impact
Threatened plants				
Ammobium craspedioides	V		V	No
Diuris tricolor	V		V	No
Amphibromus fluitans	V		V	No
Threatened animals				
Threatened woodland birds assessed as a group (Brown Treecreeper, Hooded Robin, Black-chinned Honeyeater, Painted Honeyeater, Grey-crowned Babbler, Speckled Warbler and Diamond Firetail)	V			No
Barking Owl	V			No
Bush Stone-curlew	E			No
Regent Honeyeater	E		EM	No
Superb Parrot	V		V	No
Swift Parrot	E		E	No
Turquoise Parrot	V			No
Squirrel Glider	V			No
Eastern False Pipistrelle	V			No
Greater Long-eared Bat	V		V	No
Koala	V			No
Pink-tailed Worm Lizard	V		V	No
Striped Legless Lizard	V		V	No
Southern Pygmy Perch		E		No

Notes: 1 – *Threatened Species Conservation Act 1995*, V = Vulnerable, E = Endangered. 2 – *Fisheries management Act 1994*, E = Endangered. 3 – *Environment Protection and Biodiversity Conservation Act 1999*, CE = Critically Endangered, V = Vulnerable, E = Endangered, M = Migratory. * Preliminary listing

These assessments suggest that with appropriate mitigation measures the Proposal is not likely to have a significant and long-lasting impact on the Inland Grey Box Woodland and Box-Gum Woodland as listed under the *Threatened Species Conservation Act 1995* and the equivalent communities listed (or preliminary listed) under the *Environment Protection and Biodiversity Conservation Act 1999.*

With appropriate mitigation measures, the Proposal is not likely to have a significant impact on other Threatened biodiversity (refer Appendix E). With the implementation of suitable mitigation measures as outlined in this report, it is also unlikely that non-Threatened biodiversity would be placed at risk of local extinction.

8. Conclusions

The Proposal is located in a landscape that has been significantly affected by past land uses, with much of the vegetation in the surrounding area cleared for agricultural purposes. This pattern of clearing has, however, placed greater importance on vegetation retained within the current road reserve and in areas such as the Southern Travelling Stock Reserve, much of which is now listed as a Threatened ecological community under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* and/or provides habitat for a range of Threatened species.

The proposed bypass at Tarcutta would have a substantial impact on the ecology of the local area. It would remove nearly 16 hectares of native vegetation, much of which is listed as Threatened under NSW and/or Commonwealth legislation. This vegetation also provides habitat for a range of Threatened species.

Significance assessments indicate that the Proposal is not likely to have a significant impact on Box-Gum Woodland as listed under either the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999*. Although the design of the Proposal and mitigation measures have, and would, reduce the extent of impacts on this community, they are not likely to totally ameliorate their significance.

Under the draft *Guidelines for Threatened Species Assessment under Part 3A* of the *Environmental Planning and Assessment Act 1979*, the objective of the biodiversity assessment process is to provide information to enable decision-makers to ensure that developments deliver the environmental outcomes outlined and discussed in Sections 8.1.1 to 8.1.6.

8.1.1 Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation)

The term ‘maintain or improve’ is defined in the draft *Guidelines for Threatened Species Assessment under Part 3A* of the *Environmental Planning and Assessment Act 1979* as ‘no net impact on threatened species or native vegetation.’ It is unlikely that this objective can be met with clearing of an Endangered Ecological Community. Given that the Proposal would result in clearing of native vegetation, including (Critically) Endangered Ecological Communities and habitat for Threatened species, it would be necessary to develop offset strategies to fulfil this outcome.

8.1.2 Conserve biological diversity and promote ecologically sustainable development

The Proposal has been designed to maintain vegetation in key areas along its length and to promote connectivity both along and across the road. Biodiversity was a key consideration in the location of the Proposal.

8.1.3 Protect areas of high conservation value (including areas of critical habitat)

There is no critical habitat defined within the Proposal locality. However, the vegetation within the study area does have high conservation value, given its listing under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*. The Proposal has been designed to maintain vegetation where possible, particularly at key locations, along its length (e.g. adjacent to Tarcutta Creek).

8.1.4 Prevent the extinction of threatened species

No Threatened species would become extinct as a result of the Proposal. Mitigation measures have been included to minimise impacts on Threatened species. Cumulative impacts as a result of the development of surrounding areas may, however, have significant impacts on threatened biodiversity; however, these would be dealt with and offset as required.

8.1.5 Protect the long-term viability of local populations of a species, population or ecological community

Mitigation measures have been recommended in this assessment to avoid and minimise impacts to local biodiversity. As a result, the long-term viability of most biodiversity would be protected.

8.1.6 Protect aspects of the environment that are matters of National Environmental Significance

The Proposal would not have a significant and long-lasting impact on the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland community, which is listed as Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and is, therefore, considered a matter of National Environmental Significance. Nor would the Proposal have a significant impact on other Matters of National Environmental Significance.

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