9. Assessment of key issues

This chapter assesses issues identified as key issues in the DGRs (see Appendix B and below) and in the environmental risk assessment (see Chapter 8), which may be associated with the project, including flora and fauna, Aboriginal heritage, noise and vibration, socio-economic impacts and traffic and transport.

DGRs	Where addressed
An **assessment of the key issues**, with the following aspects addressed for each key issue (where relevant): ▪ Describe the existing environment. ▪ Assess the potential impacts of the project (direct, indirect and cumulative) at both construction and operation stages, in accordance with relevant policies and guidelines. ▪ Identify how relevant planning, land use and development matters (including relevant strategic and statutory matters) have been considered in the impact assessment and/or in developing management/mitigation measures. ▪ Describe measures to be implemented to avoid, minimise, manage, mitigate, offset and/or monitor the impacts of the project and the residual impacts.	Chapter 9

9.1 Flora and fauna

A detailed flora and fauna assessment for the project was undertaken as presented below. This assessment is supported by *Technical Paper 1 — Flora and fauna* (Volume 2).

DGRs	Where addressed
Flora and fauna (including but not limited to)	
Assessment of threatened terrestrial and aquatic species, populations, ecological communities and/or critical habitat, consistent with the *Threatened Species Assessment Guidelines* (DECC, 2007), including details on the existing site conditions and quantity and likelihood of disturbance.	Sections 9.1.2, 9.1.3, 9.1.5 Chapters 4, 5 and 7 of *Technical Paper 1* (Volume 2)
Targeted surveys of threatened flora and fauna species, including White Box, Yellow Box, Blakely's Red Gum Woodland, Barking Owl, Diamond Firetail and Grey-crowned Babbler.	Section 9.1.1 Chapter 2 of *Technical Paper 1* (Volume 2)
Native vegetation loss; weed infestation; habitat fragmentation; impacts to wildlife corridors including riparian corridors; and impacts to groundwater dependent communities, riparian and aquatic habitat.	Section 9.1.3, 9.1.5 Chapters 5 and 6 of *Technical Paper 1* (Volume 2)

9.1.1 *Assessment approach*

The flora and fauna assessment was undertaken in accordance with the *Draft Guidelines for Threatened Species Assessment under Part 3A* (DEC 2005b) and the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (DEH 2006).

The assessment built on work undertaken for the *Hume Highway Holbrook bypass Preliminary Environmental Assessment* (ngh environmental 2008). A detailed description of the methodology for this assessment is provided in Chapter 2 of Technical Paper 1 (Volume 2). The assessment included:

- Review of databases and literature to identify threatened flora, fauna and ecological communities recorded, or predicted to occur, in the NSW south-western slopes bioregion.
- Terrestrial survey between 9 and 13 November 2008, and aquatic survey of Ten Mile Creek between 30 November 2008 and 2 December 2008. The surveys sought to assess the extent and condition of vegetation communities and potential flora and fauna (including fish) habitat, with particular consideration given to species of conservation concern (eg threatened and migratory species or locally significant species).
- Targeted surveys were completed for threatened flora species considered likely to be present based on findings of the database/literature review, including White Box, Yellow Box, Blakely's Red Gum Woodland. For cryptic species and where survey was completed outside the optimal time for detecting species, a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.
- Targeted surveys were completed for threatened fauna, including for Threatened woodland birds. Surveys were completed following the methodology detailed in the DECC's *NSW Threatened Species Survey and Assessment Draft Guidelines (*Working Draft) (DEC 2004). Woodland areas potentially supporting habitat for threatened woodland birds, including the Brown Treecreeper, Speckled Warbler, Barking Owl, Diamond Firetail and Grey-Crowned Babbler, were targeted as survey sites. Surveys were undertaken during different hours of the day, but generally during the morning and late afternoon. For cryptic species and where survey was completed outside the optimal time for detecting species, a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.
- Significance assessments on species, populations and ecological communities listed under the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* that were recorded or predicted to occur with a moderate or greater likelihood.

9.1.2 *Existing environment*

Landscape context

The project is located within the NSW south-western slopes bioregion, which consists of more than eight million hectares of foothills and ranges, comprising the western fall of the Great Dividing Range to the edge of the Riverina bioregion.

Remaining native vegetation in the south-western slopes bioregion is dominated by eucalypt woodlands, Callitris forests and woodlands and eucalypt tall open forests. Patches of low closed forests and closed shrublands, eucalypt open woodlands, grasslands and Acacia forests and woodlands also occur (NSW National Parks and Wildlife Service 2003). The region has been largely cleared of eucalypt woodlands for grazing and dryland agriculture, such that the larger areas of remnant vegetation occur on the rockier, hilly areas or as roadside vegetation.

The project would cross approximately 11 minor watercourses/drainage lines and Ten Mile Creek, which is a tributary of Billabong Creek. The assessment area falls within the Billabong Creek catchment (Murray Darling Basin Commission 2002). Billabong Creek flows to the west and drains to the Murray River 350 kilometres west of Holbrook.

Wildlife corridors and connectivity

Wildlife corridors are retained and/or restored linear vegetation systems that, at a minimum, enhance the connectivity of wildlife populations. These wildlife corridors are important for a range of species, functioning as areas of cover, foraging and habitat resources, and movement between habitat patches.

Vegetation within the locality of the project is highly fragmented, with isolated patches of vegetation surrounded by large expanses of cleared land. Although some vegetation patches are of sufficient size to maintain viable populations, in many cases there may be only limited connectivity among the patches, given the extent of clearing and distance between vegetation patches. In this modified landscape, vegetation within roadside reserves and riparian corridors play an important role in the connectivity of these remnant patches of vegetation.

Roadside vegetation occurs along the existing highway, and riparian corridors occur along Ten Mile Creek. This linear vegetation is likely to be used by a range of species as part of the wider corridor network.

Vegetation communities, including threatened communities

Vegetation communities

Ground-truthing, aerial photograph interpretation and detailed flora surveys identified that the majority of the assessment area is dominated by highly modified and/or artificial grassland communities associated with past intensive agricultural land uses. Where remnant vegetation is present, it is characterised by four distinct communities.

Based on classifications in the *Forest Ecosystem Classification and Mapping of the Southern Comprehensive Regional Assessment Region* (Thomas et al 2000), the following four vegetation community types occur in the assessment area:

- Blakely's Red Gum - Yellow Box grassy woodland.
- Grassy Yellow Box Woodland on Alluvial Flats.
- Grassy White Box - Blakely's Red Gum – Yellow Box woodland.
- River Red Gum very tall open forest of the NSW South Western Slopes Bioregion.

Three of the vegetation communities observed in the assessment area correspond with one state and nationally threatened ecological community, White Box, Yellow Box, Blakely's Red Gum Grassy Woodlands (Box-Gum Woodland). Table 9-1 describes the vegetation communities identified in the assessment area. Figure 9-1 shows the occurrence of these vegetation communities in the locality. Box-Gum Woodland is present in the assessment area in the north and south and in roadside reserves, the former Town Common and the Wagga Wagga Road and Culcairn Road Travelling Stock Reserves. Some exotic vegetation is present throughout the assessment area as identified in Figure 9-1.

Table 9-1 Vegetation communities identified in the assessment area

Broad community type	Vegetation community	Corresponding threatened ecological community	Observations
Forest Ecosystem 117: Western Slopes Dry Grass Woodland	Blakely's Red Gum - Yellow Box grassy woodland	White Box, Yellow Box, Blakely's Red Gum Woodland (TSC Act) [1] White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act) [1]	The community consisted of narrow remnants of semi-continuous canopy and isolated trees within the existing Hume Highway road corridor and adjoining paddocks, typically associated with minor ephemeral creek lines. Some patches were highly disturbed by past land uses, including the construction of the existing Hume Highway, grazing and other agricultural practices. These disturbances have fragmented the vegetation community and modified the floristic composition and structure. While the majority of patches of this community were in moderate condition with a mix of native and exotic groundcover species, most contained large areas dominated by exotic species.
Forest Ecosystem 117: Western Slopes Dry Grass Woodland	Grassy Yellow Box Woodland on Alluvial Flats	White Box, Yellow Box, Blakely's Red Gum Woodland (TSC Act) [1] White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act) [1]	The community consisted of narrow remnants of semi-continuous canopy and isolated trees within the roadside corridors of the existing Hume Highway and its arterial roads as well as in adjoining paddocks, typically associated with fertile floodplain soils and flats. Two large remnant patches are located in the Culcairn Road Travelling Stock Reserve and the former Town Common. These patches consist of a semi-continuous canopy of trees over a mixture of native and exotic groundcovers. Some patches were highly disturbed by past land uses, including the construction of the Hume Highway, grazing and other agricultural practices. These disturbances have fragmented the vegetation community and modified the floristic composition and structure. The majority of patches of this community were in moderate condition. Within the former Town Common and Culcairn Road Travelling Stock Reserve, this vegetation community was generally in moderate condition.

Broad community type	Vegetation community	Corresponding threatened ecological community	Observations
Forest Ecosystem 117: Western Slopes Dry Grass Woodland	Grassy White Box - Blakely's Red Gum - Yellow Box woodland	White Box, Yellow Box, Blakely's Red Gum Woodland (TSC Act) [1] White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act) [1]	This community was restricted to the north of the study area within the western portion of the Wagga Wagga Road Travelling Stock Reserve, the Hume Highway road reserve and the Wagga Wagga - Holbrook Road road reserve. Within the Wagga Wagga Road Travelling Stock Reserve, this vegetation community was in moderate condition.
Forest Ecosystem 43: Western Slopes Riparian Moist Sedge Woodland	River Red Gum very tall open forest of the NSW South Western Slopes Bioregion		Two distinct variations of this community were observed within the study area. These comprised a typical riparian association associated with Ten Mile Creek and a highly disturbed grazed paddock variation associated with the floodplain south of Holbrook. The riparian variation of this community was affected by a range of disturbances including a vehicle causeway, grazing livestock and past clearing for pasture improvements. The condition of the riparian variation of this community was typically moderate. The highly disturbed paddock variant of this community was considered to be poor condition.
-	Exotic vegetation[2]	-	Highly modified non-native vegetation, with some structure. Includes cultivated lands (not including grazed land).

Notes: 1. TSC Act = *Threatened Species Conservation Act 1995*; EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

2. The remainder of the study area contains highly modified grazing lands. Cultivated lands are not mapped in Figure 9-1.

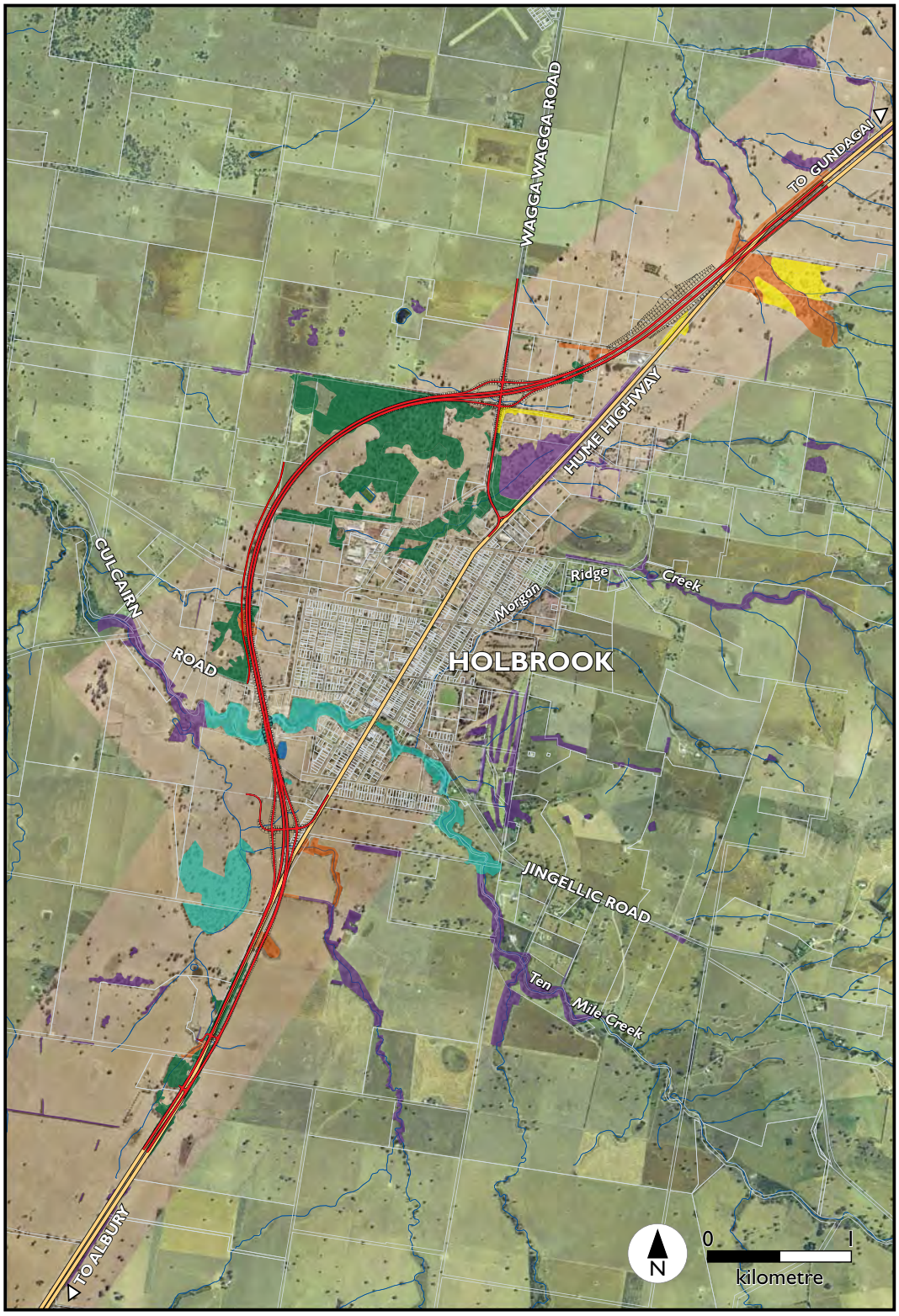

Figure 9-1 **Vegetation communities identified in the locality**

Threatened ecological communities

Box-Gum Woodland is protected under both Commonwealth and State legislation. Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland is listed as a critically endangered ecological community. Under the NSW *Threatened Species Conservation Act 1995*, White Box, Yellow Box, Blakely's Red Gum Woodland is listed as an endangered ecological community. It should be noted that the classification of the Box-Gum Woodland threatened ecological community differs under the Commonwealth and State legislation.

The *Fisheries Management Act 1994* lists the Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment as an endangered ecological community (the Lower Murray River endangered ecological community). The Lower Murray River endangered ecological community includes all natural creeks, rivers, and associated lagoons, billabongs and lakes of the regulated portions of the Murray River below Hume Weir, the Murrumbidgee River below Burrinjuck Dam, and the Tumut River below Blowering Dam, as well as their tributaries and branches. These tributaries and branches include Billabong Creek, Yanco Creek, Colombo Creek and their tributaries; the Edward River and the Wakool River and their tributaries; Frenchmans Creek, the Rufus River and Lake Victoria. The Lower Murray River endangered ecological community also includes all native fish and aquatic invertebrates within these waterbodies. Excluded from the definition are the Lachlan River and the Darling River and their tributaries. Artificial canals, water distribution and drainage works, farm dams and off-stream reservoirs are also excluded (NSW Fisheries 2002). Ten Mile Creek flows into Billabong Creek, therefore, Ten Mile Creek and its tributaries form part of this endangered ecological community (see Figure 10-1 for the drainage in the assessment area), which forms part of the Lower Murray River endangered ecological community.

Terrestrial flora, including threatened plants

A total of 190 species of plant were recorded in the assessment area, of which 91 species were native. The most diverse family recorded was the Poaceae (grasses), followed by the Asteraceae (daisies). Appendix A of Technical Paper 1 (Volume 2) lists all the plant species recorded in the assessment area. In addition, a small number of unidentified planted native and exotic cultivated species were observed in residential landscaped garden beds within the assessment area.

Threatened flora

Fourteen threatened flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999* and 16 threatened flora species listed under the *Threatened Species Conservation Act 1995* have been recorded, are predicted to occur, or have habitat in the assessment area. No threatened species were identified during field surveys for this project. Two species are considered to have a moderate likelihood of occurrence in the assessment area, based on the presence of suitable habitat and the precautionary approach adopted for the assessment. Table 9-2 lists these two species.

Table 9-2 Threatened plant species recorded or predicted to occur in the assessment area

Scientific name	Common name	Conservation significance		Habitat within the assessment area	Likelihood of occurrence in assessment area[3]
		TSC Act[1]	EPBC Act[2]		
Diuris tricolor	Pine Donkey Orchid	V	V	Box-Gum Woodlands	Moderate
Amphibromus fluitans	River Swamp Wallaby Grass	V	V	Water bodies	Moderate

Notes: 1. *Threatened Species Conservation Act 1995*, V = Vulnerable.

2. *Environment Protection and Biodiversity Conservation Act 1999*, V = Vulnerable.

3. See Appendix C of Technical Paper 1 (Volume 2) for more information on likelihood of occurrence.

Weeds

Ninety-nine weed species were recorded in the assessment area. Nine of these, shown in Table 9-3, are listed under the *Noxious Weeds Act 1993* for the Greater Hume Shire local government area. Blackberry and Willow are also listed as Weeds of National Significance (Thorp and Lynch 2000).

Table 9-3 Noxious weeds recorded in the assessment area

Scientific name	Common name	*Noxious Weeds Act 1993* control category[1]
Asparagus asparagoides	Bridal Creeper	Class 5
Echium plantagineum	Paterson's Curse	Class 4
Hypericum perforatum	St Johns Wort	Class 4
Opuntia sp	Mickey Mouse Plant	Class 4
Onopordum sp	Thistles	Class 4
Rosa rubiginosa	Sweet Briar	Class 4
Romulea rosea	Onion Grass	Class 5
Rubus fruticosus[2]	Blackberry[2]	Class 4
Salix babylonica[2]	Weeping Willow[2]	Class 5

Notes: 1: *Noxious Weeds Act 1993*: Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Class 5: The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

2: Listed as a Weed of National Significance (Thorp and Lynch 2000).

Fauna habitats

Terrestrial habitats

The suitability, size and configuration of the fauna habitats in the assessment area correlated broadly with the structure, floristics, connectivity and quality of the local and regional vegetation types, as described in Table 9-4 and shown in Figure 9-2. The majority of the fauna habitat was restricted to remnant stands of vegetation in an otherwise modified landscape. These areas of vegetation provided habitat for a range of woodland birds and mammals and limited reptiles, and were in poor to moderate condition.

Table 9-4 Fauna habitat in the assessment area with corresponding vegetation description

Fauna habitat description	Corresponding vegetation community
Box Gum Woodland	Grassy White Box - Blakely's Red Gum - Yellow Box Woodland
	Blakely's Red Gum - Yellow Box Grassy Woodland
	Grassy Yellow Box Woodland on Alluvial Flats
Riparian Woodland	River Red Gum very tall open forest of the NSW South Western Slopes Bioregion
Grazed Pasture Land	Exotic vegetation

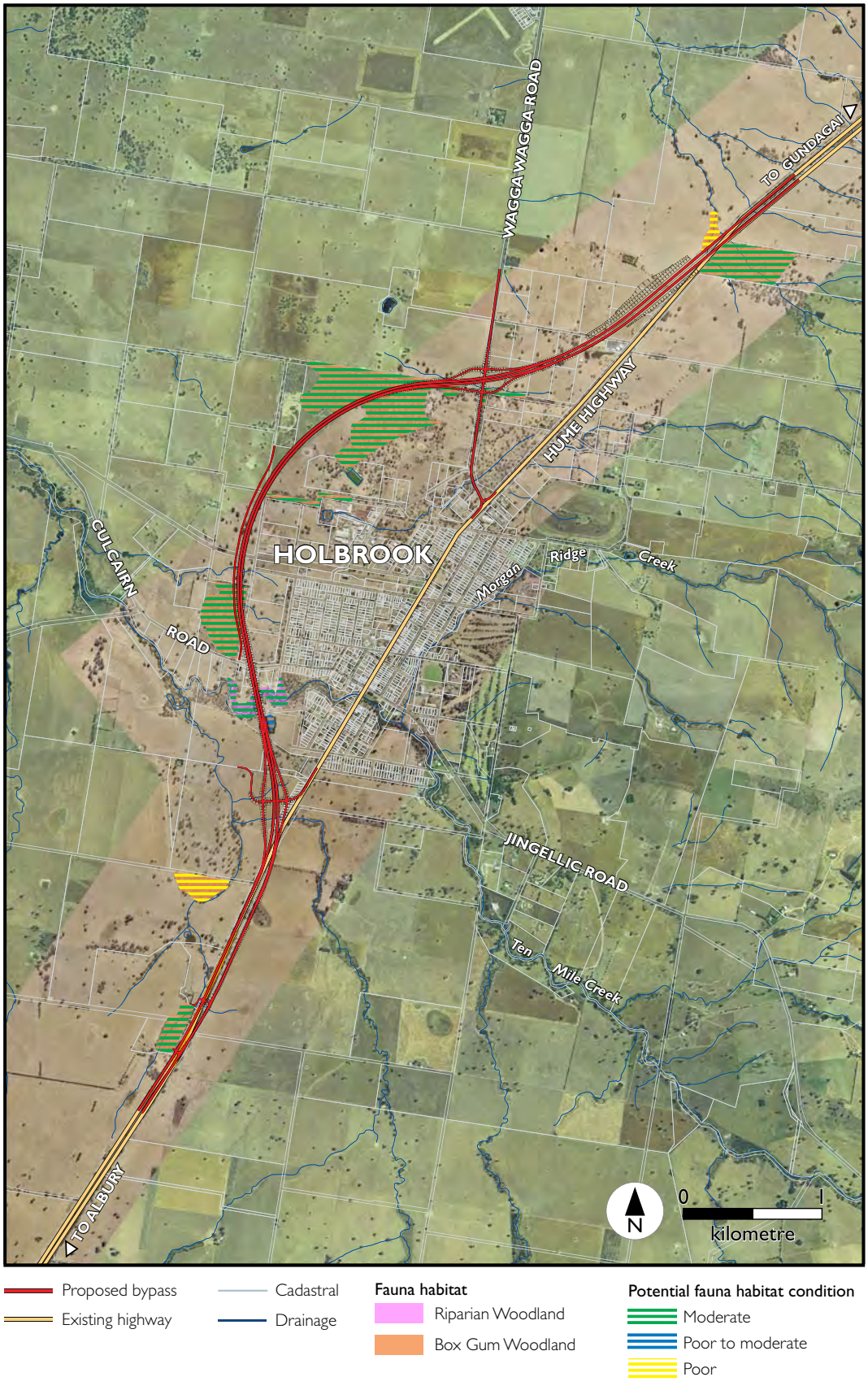

Figure 9-2 **Terrestrial fauna habitat in the assessment area**

Box-Gum Woodland habitat in the assessment area generally occurs as remnant stands of moderately to highly disturbed vegetation. Given the role of remnant vegetation in providing connectivity within the surrounding cleared landscape, Box-Gum Woodland in the assessment area is considered as having moderate value to fauna species. This habitat provides a variety of tree hollows and dead trees suitable for nesting opportunities by open country and generalist species of bird, nesting dens for arboreal mammals (including the threatened Squirrel Glider; see Table 9-5) and roosting habitat. The effects of grazing are evident in this habitat, with only the upper canopy remaining in many communities. Shrub layers and leaf litter were largely absent. Box-Gum Woodland within the Wagga Wagga Road Travelling Stock Reserve was generally in moderate condition with groundcover dominated by a diverse array of grazing sensitive native species. Box-Gum Woodland within the Culcairn Road Travelling Stock Reserve and the former Town Common was generally in moderate condition with groundcover dominated by exotic and native pasture species.

Riparian woodland habitat along Ten Mile Creek provided habitat resources for common species of amphibian and birds, with species such as Peron's Tree Frog, Red-browed Finch, Clamorous Reed Warbler, Sacred Kingfisher and Rufous Whistler. Farm dams in the assessment area did not contain riparian vegetation. They do, however, provide water resources for birds and mammals.

Grazed pasture land comprises the majority of habitats surrounding the assessment area. These areas provide limited habitat and are highly disturbed from grazing and other agricultural practices that have removed native understorey and groundcover vegetation. However, the isolated paddock trees within the grazed pasture land are important in providing habitat for a range of fauna and maintaining connectivity between larger vegetation patches (Gibbons and Boak 2000).

Aquatic habitats

Ten Mile Creek is the only Class 1 waterway (major fish habitat in a permanently or intermittently flowing waterway), as defined by the Department of Industry and Investment (Fairfull and Witheridge 2003), within the assessment area. Other minor drainage lines within the assessment area are classed as Class 3 waterways (minimal fish habitat).

Ten Mile Creek has been modified as a result of anthropogenic disturbance, which includes agricultural activities, clearing and grazing of cattle. There was significant aquatic habitat degradation of Ten Mile Creek in the locality. Riparian bank vegetation was dominated by weeds. Water quality within the assessment area, as measured using physico-chemical variables, was generally within the ANZECC (2000) guidelines. In general, the richness and abundance of fish within the assessment area was quite low and dominated by exotic species. No native fish were recorded in the locations sampled at Holbrook. One species of native fish has the potential to be present in the assessment area — Southern Pygmy Perch.

The aquatic habitat of Ten Mile Creek forms part of the Lower Murray River endangered ecological community.

Terrestrial fauna, including threatened and migratory animals

A total of 98 species of animal were recorded in the assessment area, of which 92 species were native. Native birds were the most diverse group of animals recorded (72 species), the majority of which were common, open country generalists or species common to grassy woodland environments (eg White-winged Chough, Galah and Eastern Rosella). Twelve species of native mammal, including eight species of microchiropteran bat typical of open woodland areas, were recorded. Eight reptile and four amphibian species were also recorded.

Appendix B of Technical Paper 1 (Volume 2) lists all of the animal species recorded in the assessment area.

Threatened terrestrial fauna

Ten threatened fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999* have been recorded, are predicted to occur, or have potential habitat, in the assessment area. Six of the ten species are considered to have a low likelihood of occurrence. The remaining four species are considered to have a moderate or high likelihood of occurrence. This includes the threatened Superb Parrot, which was recorded during survey within Box-Gum Woodland.

Twenty threatened fauna species listed under the *Threatened Species Conservation Act 1995* have been recorded, are predicted to occur or have habitat in the assessment area. Four of these species are considered to have a low likelihood of occurrence. Fifteen of these species are considered to have a moderate or high likelihood of occurrence. This includes the threatened Brown Treecreeper, which was recorded during survey within Box-Gum Woodland adjacent to the existing Hume Highway.

Details of the state and nationally threatened terrestrial fauna species recorded or predicted to occur in the assessment area are provided in Table 9-5.

Table 9-5 Threatened terrestrial fauna recorded or predicted to occur in the assessment area

Scientific name	Common name	Conservation significance		Habitat within the assessment area	Likelihood of occurrence in assessment area[4]
		TSC Act[1]	EPBC Act[2]		
Birds					
Burhinus grallanius	Bush Stone-curlew	E		Box-Gum Woodland, Riparian Woodland	Moderate
Climacteris picumnus	Brown Treecreeper[3]	V		Box-Gum Woodland	High
Grantiella picta	Painted Honeyeater	V		Box-Gum Woodland	Moderate
Lathamus discolour	Swift Parrot	E	EM	Box-Gum Woodland	Moderate
Melanodryas cucullata	Hooded Robin	V		Box-Gum Woodland	Moderate
Melitreptus gularis gularis	Black-chinned Honeyeater	V		Box-Gum Woodland	Moderate
Neophema pulchella	Turquoise Parrot	V		Box-Gum Woodland	Moderate
Ninox connivens	Barking Owl	V		Box-Gum Woodland, Riparian Woodland	Moderate
Polytelis swainsonii	Superb Parrot[3]	V	V	Riparian Woodland	High
Pomatostomus temporalis	Grey-crowned Babbler	V		Box-Gum Woodland	Moderate
Pyrrholaemus sagittatus	Speckled Warbler	V		Box-Gum Woodland	Moderate
Stagonopleura guttata	Diamond Firetail	V		Box-Gum Woodland	Moderate
Xanthomyza Phrygia	Regent Honeyeater	E	EM	Box-Gum Woodland, Riparian Woodland	Moderate
Mammals					
Nyctophilus timoriensis	Greater Long-eared Bat	V	V	Box-Gum Woodland	Moderate
Petaurus norfolcensis	Squirrel Glider	V(E2)		Box-Gum Woodland	Moderate

Notes: 1: *Threatened Species Conservation Act 1995*, V = Vulnerable, E = Endangered, E2 = Endangered population.

2: *Environment Protection and Biodiversity Conservation Act 1999*, V = Vulnerable, E = Endangered, M = Migratory.

3: Species was recorded during field surveys for this project.

Migratory species

Migratory species are protected under the international agreements to which Australia is a signatory. Migratory species are considered matters of national environmental significance and are protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

No species recorded during field surveys is currently recognised under the migratory provisions of the *Environment Protection and Biodiversity Conservation Act 1999*. Ten species have the potential to occur in the project locality based on the EPBC Protected Matters Search Tool.

The assessment area is only considered important habitat (providing foraging resources and potential nesting resources) for one of these 10 migratory species, the Regent Honeyeater. The Regent Honeyeater is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and the assessment area could be considered to contain habitat where the species is declining. An assessment of significance was carried out for this migratory species using the threatened species criteria (see Appendix E of Technical Paper 1 (Volume 2)).

Introduced animals

Six introduced species were recorded in the assessment area: Spotted Turtle-Dove, Common Blackbird, House Sparrow, Common Starling, Brown Hare and Rabbit.

Aquatic biodiversity

Three species of fish were recorded during surveys of Ten Mile Creek (which is part of the Lower Murray River endangered ecological community). The most abundant fish caught was the introduced Mosquito Fish (*Gambusia holbrooki*), followed by the Goldfish (*Carassius auratus*) and the Common Carp (*Cyprinus carpio*). No native fish were collected at the three locations.

Two species of crustacean were recorded during the surveys. These were Freshwater Shrimp (*Paratya australiensis*) and Yabby (*Cherax* sp.).

One species of native fish has a moderate likelihood of occurrence in the assessment area — the Southern Pygmy Perch.

Twenty-four macroinvertebrate taxa were collected from the three survey locations in Ten Mile Creek. The most abundant were Copepods (Cyclopoida) followed by Water Fleas (Daphniidae) and Oligochaete Worms (Lumbiculidae). The relatively large number of pollution tolerant macroinvertebrate taxa suggested that the water quality in Ten Mile Creek was generally quite poor.

9.1.3 *Impacts on flora and fauna*

Loss of native vegetation and fauna habitats

The project would require the clearing of 24 hectares of native vegetation. The clearing would comprise:

- Twenty-two hectares of Box-Gum Woodland (an endangered ecological community under the *Threatened Species Conservation Act 1995*), 20 hectares of which fits the definition of the critically endangered ecological community under the *Environment Protection and Biodiversity Conservation Act 1999*.
- Two hectares of River Red Gum very tall open forest of the NSW South Western Slopes Bioregion.

This vegetation clearance would result in the loss of 24 hectares of identified fauna habitat including 22 hectares of Box-Gum Woodland and two hectares of Riparian Woodland. Impacts on areas of roadside vegetation and Travelling Stock Reserves would generally involve the loss of key habitat components for a range of fauna (spread over eight remnants of vegetation), including hollow-bearing trees, mature habitat trees (foraging resources) and dead/downed timber.

Table 9-6 details the vegetation and habitat loss required for the project.

Table 9-6 Vegetation communities and fauna habitat required to be cleared

Vegetation community	Corresponding threatened ecological community[1]	Corresponding fauna habitat	Total clearing (within the construction site boundary) (hectares)
Vegetation community			
Blakely's Red Gum - Yellow Box grassy woodland	Box-Gum Woodland	Box-Gum Woodland	7
Grassy Yellow Box tall woodland on alluvial flats	Box-Gum Woodland	Box-Gum Woodland	14
Grassy White Box - Blakely's Red Gum - Yellow Box woodland	Box-Gum Woodland	Box-Gum Woodland	1
River Red Gum very tall open forest of the NSW South Western Slopes Bioregion	-	Riparian Woodland	2
Disturbed exotic vegetation[2]	-	-	1
Total			25

Notes: 1. Endangered ecological communities listed under the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999*.

2. Non-native vegetation

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.*

Habitat fragmentation and wildlife corridor impacts

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 is often artificial and inhospitable to the species remaining in the fragments (Johnson et al 2007; Bennett 1993, 1990). Habitat fragmentation can result in a number of impacts, including:

- Barrier effects: where particular species are either unable or unwilling to move between suitable areas of fragmented habitat.
- Genetic isolation: where individuals from a population in one fragment are unable to interbreed with individuals from populations in adjoining fragments.
- Edge effects: where a zone of changed environmental conditions (ie altered light levels, wind speed and/or temperature) occurs along the edges of habitat fragments (see below).

The construction and operation of the project would further fragment habitat and increase the isolation of remnant vegetation. With the project traversing Travelling Stock Reserves, roadside and riparian corridor vegetation and modified agricultural landscapes, the level of fragmentation and isolation of some patches of vegetation would increase.

The project is likely to significantly fragment the former Town Common through the clearance of approximately five hectares of vegetation. In general, the vegetation in the former Town Common was in poor to moderate condition, with the better quality portions located in the adjoining road reserves, waste water treatment plant and cemetery to the south of the proposed alignment. The project would bisect the central portions of the former Town Common affected by intensive grazing and pasture improvement. The project would avoid significant fragmentation impacts in the Culcairn Road and Wagga Wagga Road Travelling Stock Reserves as it is located on the periphery of these reserves.

The project would also present a barrier within the landscape (in an east-west direction) along the Ten Mile Creek wildlife corridor and within remnant patches in the former Town Common and the Culcairn Road Travelling Stock Reserve. The barrier effect would be greatest for small and sedentary fauna, such as ground-dwelling/arboreal mammals, reptiles and amphibians. However, given the existing disturbances in the assessment area due to a history of agricultural land uses and the existing Hume Highway, the disrupted wildlife corridors are likely to be used mostly by highly mobile species, such as birds and bats, primarily as marginal foraging habitats within a greater foraging range. The project is unlikely to have a significant impact on these highly mobile species provided that the impacts to wildlife corridors are mitigated through the measures identified in Section 9.1.4.

Edge effects

Edge effects are zones of changed environmental conditions 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.

The majority of vegetation in the assessment area occurs within relatively small, fragmented patches, many of which are subject to past and present disturbance regimes (eg grazing) so already consist of edge-affected habitats. Construction of the project is likely to introduce new edge effects to the larger remnants of vegetation such as the former Town Common. Within the Culcairn Road Travelling Stock Reserve, the project would be largely located along an existing road, which would minimise the introduction of new edge effects in this area. Approximately five hectares of habitat is expected to be altered as a result of introducing edge effects associated with the project.

A change in the microhabitat conditions in remnant vegetation patches as a result of vegetation clearing and earthworks increases the likelihood of germination and establishment of weeds. Given the significant disturbances associated with edge effects from grazing and adjoining agricultural land practices, any marginal increase in these effects caused by the project is not likely to be significant.

Vehicle strike and direct mortality of animals

Fauna injury or death could occur during construction when vegetation and habitats are being cleared. While some mobile species (eg 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.

During operation of the project, fauna injury or death could also occur as a result of collision with vehicles. Threatened fauna that may be affected by vehicle strikes include the Squirrel Glider, the Swift Parrot and woodland bird species, such as the Grey-crowned Babbler. The greatest road kill risk for these species would likely occur where the alignment traverses, or is in the vicinity of, the Wagga Wagga Road and Culcairn Road Travelling Stock Reserves, the former Town Common and Ten Mile Creek.

As detailed in Table 9-8, the project would adopt procedures to prevent fauna mortality during construction and operation.

Invasion and establishment of weed and pest species

As identified in Section 9.1.2, 99 species of weed were observed to be widespread across the assessment area.

Construction of the project 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 would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery. Given that most of the vegetation in the assessment area already has considerable weed growth, the overall extent of habitat modification through weed establishment is not likely to increase significantly.

Weed management during operation would be carried out as part of regular maintenance activities, if required.

Aquatic flora and fauna impacts

The construction of waterway crossings for the project (temporary and permanent) has the potential to modify the natural hydrology of creeks within the assessment area, which could affect the aquatic assemblages that use these areas. Potential impacts on hydrology from the construction of waterway crossings include:

- Excessive flow velocities.
- Modified water depths in creeks.
- Increased water turbulence.

Barriers to fish passage from the installation of waterway crossings (including bridges and culverts) can occur temporarily (ie during construction) and/or over the long term if inappropriate structures are used. In addition to potential impacts from alteration of natural hydrology at waterway crossings, other impacts, such as decreased light levels and blockage by debris, may affect fish passage. Culverts and bridge pillars associated with the existing highway are located within Ten Mile Creek and a number of its tributaries, which may potentially already disrupt fish passage.

Fish and mobile invertebrate assemblages surveyed in Ten Mile Creek were fairly typical of freshwater habitats in the region and the fish assemblage consisted of introduced species. A small area of the threatened Southern Pygmy Perch habitat could be removed as a result of constructing the proposed waterway crossing at Ten Mile Creek. However, no bridge piles would be located in the preferred habitat of this species (the low flow channel of the creek). Given that suitable habitat would remain upstream and downstream of the project, and provided that fish passage is maintained in accordance with the Department of Industry and Investment guidelines (Fairfull and Witheridge 2003), no long-term impacts from the proposed waterway crossings would be expected for the Southern Pygmy Perch or other fish species (see Appendix E of Technical Paper 1 (Volume 2)).

Ten Mile Creek forms part of the Lower Murray River endangered ecological community. The project would include (temporary and permanent) waterway crossings within this endangered ecological community, which would add to the overall disturbance regime in the creeks. The waterways within the assessment area are currently affected by riparian vegetation clearance, erosion and sedimentation, alteration to flows and bank instability due to stock access and vegetation removal. Given that suitable habitat exists upstream and downstream of the proposed creek crossings, and that all crossing would be constructed in accordance with the Department of Industry and Investment (formerly the DPI) guidelines, it is unlikely that there would be long-term impacts on the endangered ecological community.

During construction, runoff from disturbed surfaces would have the potential to affect water quality in local creeks due to sedimentation. There is also potential for accidental spillage/leakage of road construction materials, fuels, lubricants and hydraulic oils from construction equipment (this is discussed in Sections 10.4 and 10.6). During operation, traffic accidents may results in similar accidental spillage of fuels, lubricants and hydraulic oils from vehicles, while the paved surface of the project would increase stormwater runoff volumes and flows. This could increase flood levels and velocities in drainage lines downstream of the highway. This is not likely to be significant.

Impacts on groundwater dependent ecosystems

Groundwater dependent ecosystems are communities of plants, animals and other organisms whose extent and life processes depend on groundwater (DLWC 2002). Within the assessment area, there are two main groundwater flow systems: fractured rock and alluvial aquifers (see Section 10.1). Much of the vegetation in the assessment area is likely to access these groundwater resources. However, given the broad regional distribution of these communities and the varied topography over which they occur, it is unlikely that they would be dependent on the groundwater resources. River Red Gums and other riparian vegetation may show a partial dependence on the groundwater, but their extent and life processes are not wholly dependent on groundwater.

An area of vegetation located on the eastern side of the existing Hume Highway, to the south of Holbrook, has previously been identified as a potentially groundwater dependent ecosystem. Field inspections of this area completed during the flora surveys indentified a slight damp depression with small number of moisture tolerant groundcover species. However, the dominant groundcover species and canopy was considered characteristic of the surrounding Box-Gum Woodland vegetation and is not considered to be a groundwater dependent ecosystem.

The project would require the excavation and shaping of the upper soil profile and minor alterations to the existing surface water drainage. Some groundwater extraction may be required for construction activities. This is not expected to have a significant impact on the existing subsurface aquifers and their associated groundwater dependent ecosystems.

Cumulative impacts

The cumulative biodiversity impacts of the project considered in this environmental assessment are likely to be more substantial as a result of biodiversity impacts from the surrounding Hume Highway duplication and proposed town bypass projects. These cumulative impacts would include a greater extent of clearing of native vegetation and habitats, including threatened ecological communities, as well as further fragmentation of habitats, including habitat for threatened flora and fauna.

It is estimated that a total of approximately 133 hectares of native vegetation has been, or will be, cleared for the current duplication and proposed town bypass projects on the Hume Highway. The project would contribute approximately 19 per cent of this clearing. The total extent includes an estimated 98 hectares of endangered ecological communities, of which the project contributes up to 21 hectares. The loss of 100 hectares of endangered ecological communities is considered a significant loss given the threatened status of these communities and the largely fragmented nature of remnant vegetation patches within the south-western slopes bioregion. To offset the loss of native vegetation as a result of the Hume Highway duplication projects, the RTA is implementing a biodiversity offset package.

While similar or better quality vegetation and habitat remain within the bioregion, the extent of clearing for the Hume Highway duplication and proposed bypass projects would reduce the extent of viable habitat. However, this would be a minimal loss of vegetation and fauna habitat in the context of the wider bioregion.

Significance of impacts

Significance assessments were completed for threatened biodiversity that were known or likely to occur within the assessment area, including two endangered ecological communities, two species of plant and 14 species of animal. Table 9-7 summarises the significance assessments. This is supported by the detailed assessments in Appendix E of Technical Paper 1 (Volume 2).

Table 9-7 Summary of significance assessments for threatened biodiversity

Threatened biodiversity	TSC Act[1]	FM Act[2]	EPBC Act[3]	Likely significant impact
Ecological communities				
Box Gum Woodland	E		CE	Yes
Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment		E		No
Plants				
Diurus tricolor (Pine Donkey Orchid)	V		V	No
Amphibromus fluitans (River Swamp Wallaby-grass)	V		V	No
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
Turquoise Parrot	V			No
Barking Owl	V			No
Regent Honeyeater	E		EM	No
Superb Parrot	V		V	No
Swift Parrot	E		EM	No
Bush Stone-curlew	E			No
Squirrel Glider	V			No
Greater Long-eared Bat	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*, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory.

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

For the other threatened biodiversity, the assessments indicate that the project is not likely to have a significant or long lasting impact.

9.1.4 *Management of impacts*

Management measures for flora and fauna impacts were developed following the general principles, in order of preference, of:

- Avoiding impacts.
- Minimising impacts.
- Mitigating impacts.
- Offsetting of residual impacts (this is considered a last resort, once the above options have been investigated).

The planning and route selection processes have, as far as possible, avoided impacts on flora and fauna habitats. Chapter 4 discusses the route selection process that was undertaken for this project, and particularly identifies that impacts to flora and fauna were a key consideration in the planning and route selection.

Table 9-8 identifies mitigation and management measures that would be implemented for flora and fauna impacts. These measures have been incorporated into the draft statement of commitments in Chapter 11.

Table 9-8 Flora and fauna mitigation and management measures

Potential impact	Mitigation and management measure
Pre-construction	
Impacts on flora and fauna from construction of the project	▪ Prior to the commencement of construction, prepare and implement a Flora and Fauna Management Plan through the CEMP.
Construction	
Removal of native vegetation and increased edge effects	▪ Limit clearing and disturbance of native vegetation to the minimum necessary to construct and operate the project through detailed design.
Removal of habitat	▪ Implement clearing protocols that involve checking hollow-bearing trees for the presence of bird nests and arboreal animals, such as possums, gliders and bats prior to felling or pushing. Safely remove any animals found to be occupying trees. Have a qualified ecologist relocate any fauna with the potential to be harmed into suitable adjacent habitat. ▪ Implement a two stage clearing process for the removal of all hollow-bearing trees. ▪ Attach nest boxes to trees in a way that allows for tree expansion and does not poison the tree. When locating nest boxes or hollows, consider aspect, height and location appropriate for the target fauna species. ▪ Collect native seed prior to clearing, for use in the revegetation of disturbed areas.

Potential impact	Mitigation and management measure
	▪ Landscape areas within the project corridor, including use of native plant species endemic to the area. ▪ Implement strategic revegetation works in the highway corridor to increase fauna habitat linkages and enhance riparian areas.
Increased weed invasion in adjacent areas due to edge effects	▪ Undertake ongoing management of weeds in consultation with the Greater Hume Shire Council.
Inadvertent disturbance of Box-Gum Woodland outside construction areas	▪ Clearly demarcate the limits of clearing within the construction site boundary prior to construction activities commencing to avoid unnecessary vegetation and habitat removal.
Cumulative loss of habitat	▪ Place natural and artificial habitat features into suitable areas to provide alternate habitat for fauna.
Fragmentation of habitat	▪ Develop fauna crossing treatments in consultation with the relevant government agencies.
Changed hydrology and aquatic disturbance and barriers to fish passage	▪ Avoid works within the main watercourse of Ten Mile Creek during the breeding season of the Southern Pygmy Perch (September to January) unless mitigation measures are developed in consultation with the Department of Industry and Investment. ▪ Maintain fish passage during construction. ▪ Design waterway crossings, including temporary works, in accordance with the fish habitat classification of each waterway and in consultation with the Department of Industry and Investment. ▪ Follow Department of Industry and Investment guidelines, so as to maintain the natural flow of all water bodies directly affected by the project within the assessment area.
Decreased water quality	▪ Develop and implement best practice environmental management measures during construction in accordance with *Managing Urban Stormwater: Soils and Construction, Volume 1 4th Ed.* (Landcom 2006) and *Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction* (DECC 2008b).
Operation	
Offset the loss of vegetation and fauna habitat, and residual impacts	▪ Develop a biodiversity offset package in consultation with the DECCW to detail how residual impacts on the ecological values as a result of the project would be managed. The package would address the potential cumulative impacts resulting from the proposed Tarcutta and Woomargama bypasses. This offset package would be guided by the RTA (2007b) *Hume Highway Duplication Biodiversity Offset Strategy*.

9.2 Aboriginal heritage

An assessment of Aboriginal cultural heritage impacts has been undertaken for the project as presented below. This is supported by an Aboriginal Cultural Heritage Assessment Report (CHAR) in *Technical Paper 2 — Aboriginal Heritage* (Volume 2).

DGRs	Where addressed
Aboriginal heritage (including but not limited to):	
Detailed archaeological heritage assessment, including archaeological survey to determine the extent of Aboriginal occupation and land use.	Section 9.2.1, 9.2.2, 9.2.3, 9.2.4 and 7.3.1 Technical Paper 2 (Volume 2)
Cultural heritage assessment to identify the cultural value of the area to Aboriginal people in the present and historically.	

9.2.1 Assessment approach

The Aboriginal cultural heritage assessment was undertaken in accordance with the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005a), *Interim Community Consultation Requirements for Applicants* (DEC 2005a) and the *RTA Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (RTA 2008d) (the Procedure).

The assessment of Aboriginal cultural heritage consisted of desktop research, database searches, Aboriginal community consultation, cultural interviews, cultural mapping, archaeological field surveys and test excavations. The assessment included the following elements:

- A search of the DECCW Aboriginal Heritage Information Management System (AHIMS) database within 10 kilometres of Holbrook.
- A review of previous archaeological surveys undertaken for the Hume Highway upgrade including Kelleher Nightingale Consulting Pty Ltd (2007a, b, c).
- Identification, registration and consultation with Aboriginal stakeholders.
- Three Aboriginal focus group meetings were held to discuss:
  - The preliminary archaeological assessment.
  - The survey and methodology for the test excavation program.
  - The draft CHAR, prior to submission of comments.
- Aboriginal cultural knowledge holders were identified through the Aboriginal focus group processes. Seven of the identified knowledge holders were provided the opportunity to participate in the cultural assessment process. As a result three of the identified knowledge holders participated in the cultural heritage assessment through field surveys and interviews.
- A review of the preliminary archaeological assessment and cultural mapping undertaken as part of the preliminary environmental assessment.
- An archaeological surface survey of the assessment area was conducted on 13 and 14 November 2008, with a follow up survey on the 15 and 16 of December 2008. The survey consisted of two teams of five to six people, including archaeologists and Aboriginal stakeholders, walking the assessment area to identify areas of archaeological significance or potential significance.
- An assessment of Aboriginal cultural heritage was undertaken, consisting of both interviews and field surveys.

- Test excavations were undertaken in March and April 2009 in four locations (four sites identified during the surface surveys) in order to determine the extent and significance of Aboriginal archaeology.
- An assessment of archaeological and cultural significance, in accordance with *Standards for Archaeological Practice in Aboriginal Heritage Management Guidelines* (NPWS 1997):
  - Archaeological significance rankings for archaeological sites include consideration of archaeological research potential, representativeness and rarity. Levels of significance include low, medium and high.
  - Cultural significance refers to the values of a place, feature or site to a particular community group and can include social, spiritual, historic and archaeological values. Cultural significance for the places and items identified in the Aboriginal cultural heritage assessment were given a relative ranking of low, medium, high or very high.
- A draft Aboriginal CHAR was prepared and circulated to the registered stakeholders for comment. No comments were received during or after the consultation period. The final CHAR is included as Technical Paper 2 (Volume 2).

9.2.2 Existing environment

Aboriginal archaeology

Survey and testing has confirmed what many Aboriginal people have always known: Holbrook was an important oasis among the plains. Aboriginal people came to Holbrook while travelling to a further destination, in much the same way that travellers today pass through the town. However, the archaeological story indicates that some of these travellers stayed in the Holbrook area for some time.

Water is the controlling feature of the archaeology of Holbrook. Water features such as Ten Mile Creek, Billabong Creek and related springs and swamps have a direct correlation with archaeology. High energy fluvial events (fast moving creeks) and static water sources (swamps, springs, billabongs) combine to indicate the history of Aboriginal occupation near these important resources.

Archaeological sites in the assessment area occur as artefact scatters and scarred trees, no potential archaeological deposits (PADs) were identified. Artefact scatters are areas in the landscape that contain two or more stone artefacts, generally located within 100 metres of each other. They may result from the activities of a single person or a group of people and can be the result of a single occupation or multiple episodes of occupation of a single place. Scarred trees are trees that have had bark deliberately removed that leaves scars on the tree trunk, which indicates the Aboriginal use of an area. The bark was used for many purposes, including canoes, shelters, shields and container vessels.

The AHIMS search did not identify any previously recorded sites within the locality.

A total of 13 Aboriginal archaeological sites were identified during the archaeological surface survey for the project. These sites are found in a range of landforms, which effectively characterise Holbrook's landscape (eg creeks, swamps, springs, slopes, hills) and are, therefore, well placed to offer insights into the array of Aboriginal cultural activities. The sites include: 11 artefact scatters, one isolated find and one scarred tree.

Test excavations were undertaken in four locations to determine the extent and significance of Aboriginal archaeology. The methodology for the test excavations is summarised in Chapter 6 of Technical Paper 2 (Volume 2).

The identified Aboriginal archaeological items within the assessment area are listed in Table 9-9. The archaeological significance ranking of these sites is also provided. All identified sites were considered to be of high cultural significance to the Aboriginal stakeholders.

The approximate locations of the archaeological sites are shown in Figure 9-3.

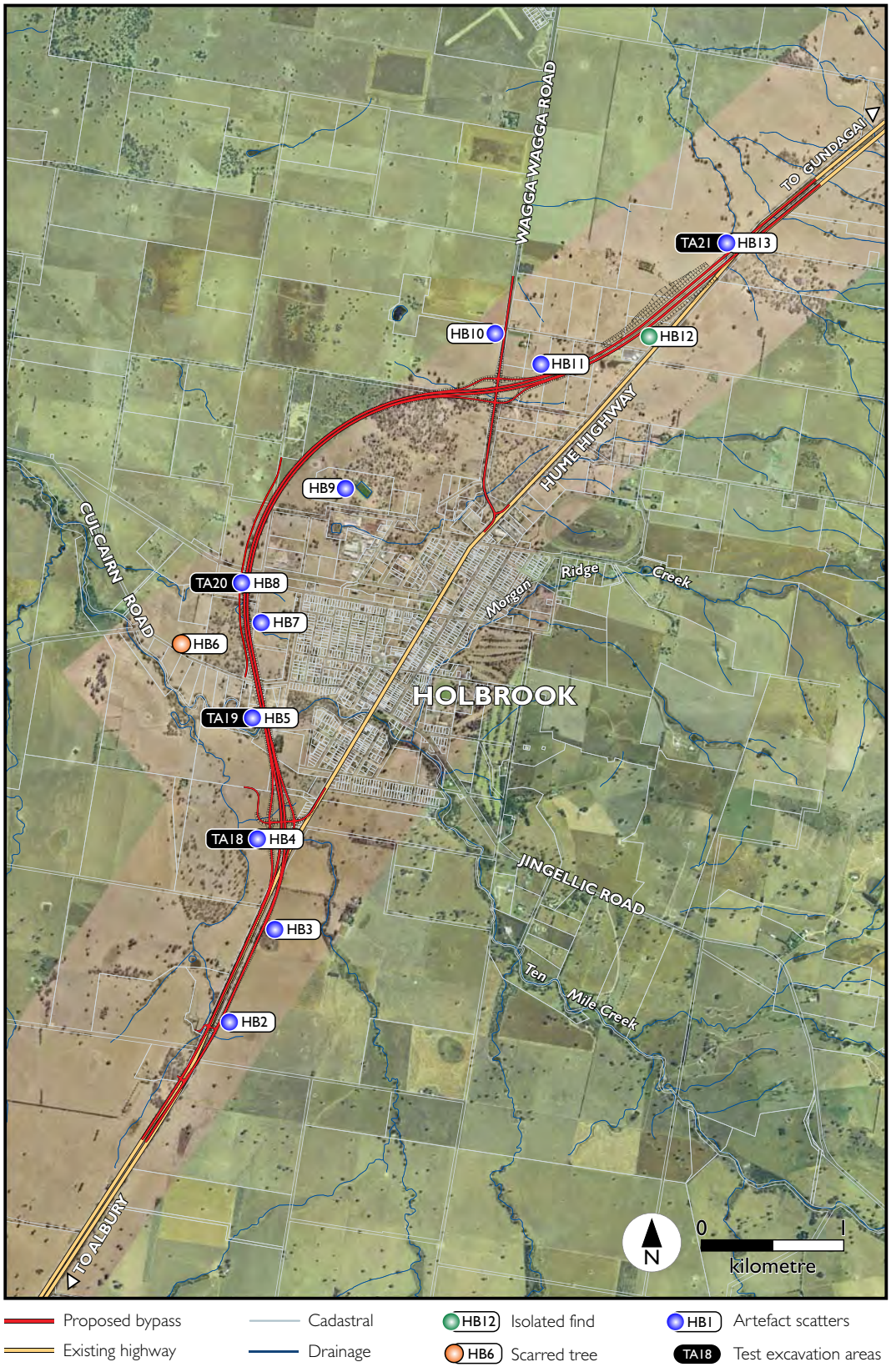

Figure 9-3 **Locations of identified Aboriginal archaeological sites**

Cultural places

Twenty places of specific Aboriginal cultural value were identified by the knowledge holders within the Aboriginal cultural heritage study area. These places are recognised by the knowledge holders as being part of one interlinked element within the larger cultural landscape. The cultural significance of these places ranged from medium to very high. This ranking was developed in consultation with the knowledge holders. All identified places hold Aboriginal cultural heritage significance, the relative ranking is designed only to assist future planning. The identified Aboriginal cultural places are listed in Table 9-9. Locations of the identified places have been kept confidential due to the culturally sensitive nature of this information.

Table 9-9 Identified items of archaeological and cultural significance

Site	Site type	Significance
HB1	Artefact scatter	Moderate to high
HB2	Artefact scatter	Moderate to high
HB3	Artefact scatter	Moderate to high
HB4[1]	Artefact scatter	High
HB5[1]	Artefact scatter	High
HB6	Scarred tree	High
HB7	Artefact scatter	Moderate to high
HB8[1]	Artefact scatter	Moderate to high
HB9	Artefact scatter	High
HB10	Artefact scatter	High
HB11	Artefact scatter	Low to moderate
HB12	Isolated find	Low
HB13[1]	Artefact scatter	Low
Place 1	Ancestor figure	Very high
Place 2	Ceremonial area	Very high
Place 3	Totem marker	Very high
Place 4	Cultural tree	Very high
Place 5	Cultural tree	High
Place 6	Cultural tree	High
Place 7	Cultural tree	Medium
Place 8	Cultural tree	High
Place 9	Cultural tree	High
Place 10	Cultural tree	Very high
Place 11	Cultural tree	High
Place 12	Cultural tree	High
Place 13	Cultural tree	Very high
Place 14	Cultural tree	High
Place 15	Cultural tree	Medium
Place 16	Cultural tree	High

Site	Site type	Significance
Place 17	Cultural trees and water location	High
Place 18	Cultural tree	Very high
Place 19	Cultural trees	Very high
Place 20	Cultural tree	High significance

Note: 1. Site subject to test excavation.

9.2.3 Impacts on items of heritage significance

All identified Aboriginal cultural places and archaeological sites recorded within the assessment area have been considered throughout the environmental assessment process. Where significant sites or places were identified, the concept design has been modified where possible to avoid or limit the impact to the identified cultural places and archaeological sites. Some level of impact has been unavoidable.

Archaeological sites

Of the 13 archaeological sites identified, nine are located wholly or partially within the construction site boundary and would be directly impacted by the project. In most cases the impacts amount to only a relatively small portion of the site. Detailed design would seek to further minimise impacts on these archaeological sites, where feasible. The four archaeological sites located outside the construction site boundary would not be directly impacted by the project. A summary of the archaeological heritage impacts is provided in Table 9-10.

The project provides an opportunity to increase understanding, strengthen interpretation and better recognition of Aboriginal culture and heritage within an area where little previous documented information exists.

Cultural places

Seven of the 20 identified cultural places are located partially or wholly within the construction site boundary and would be directly impacted by the project. Impacts on these places have been discussed and agreed to by the knowledge holders, subject to specific mitigation measures. A summary of the impacts to cultural places is provided in Table 9-10.

Table 9-10 Summary of impacts to, and mitigation measures for Aboriginal archaeological sites and cultural places

Site	Extent of impact and mitigation measures
HB1 — Artefact scatter	Would be impacted. Salvage excavation recommended.
HB2 — Artefact scatter	Would be impacted. Salvage excavation recommended.
HB3 — Artefact scatter	Would be impacted. Salvage excavation recommended.
HB4 — Artefact scatter	Would be impacted. Partial impact only. Salvage excavation recommended to the (impacted) eastern portion of the site. If the western portion is impacted as a result of detailed design a second salvage excavation is recommended.
HB5 — Artefact scatter	Would be impacted. Salvage excavation recommended.
HB6 — Scarred tree	No impact. Identify location of scar tree on heritage site map. Fence if within construction site boundary.
HB7 — Artefact scatter	No impact. Identify the location of the site on heritage site map. Fence if within construction site boundary.
HB8 — Artefact scatter	Would be impacted. Salvage excavation recommended.

Site	Extent of impact and mitigation measures
HB9 — Artefact scatter	No impact. Identify the location of the site on heritage site map. Fence if within construction site boundary.
HB10 — Artefact scatter	No impact. Identify the location of the site on heritage site map. Fence if within construction site boundary.
HB11 — Artefact scatter	Would be impacted. Artefacts should be salvaged by surface collection within the impact area.
HB12 — Isolated find	Would be impacted. Artefacts should be salvaged by surface collection within the impact area.
HB13 — Artefact scatter	Would be impacted. Artefacts should be salvaged by surface collection within the impact area.
Place 1	Would be impacted. Partial impact only. Identify location on heritage site map. Fence along construction site boundary. Knowledge holder has requested cultural salvage of the impacted Place. Sensitive area signage to be erected on construction site boundary fence. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 2	No impact. Identify location on heritage site map. Fence if within construction site boundary.
Place 3	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 4, Place 15, Place 16, Place 17, Place 18 and Place 19	Would be impacted. Identify location on heritage site map. Fence along construction site boundary. Funding to be provided for a cultural heritage consultant and the knowledge holders to be engaged to design cultural heritage interpretative signage in relation to the cultural values of the trees. This interpretative signage should then be displayed by the RTA within the Holbrook area, subject to agreement by relevant stakeholders, (eg Greater Hume Shire Council). This work would be undertaken as mitigation in relation to the impacts on Place 4, Place 15, Place 16, Place 17, Place 18 and Place 19.
Place 5	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 6	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 7	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 8	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.

Site	Extent of impact and mitigation measures
Place 9	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 10	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 11	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 12	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 13	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 14	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.
Place 20	No impact. Identify location on heritage site map. Fence if within construction site boundary. Any future work in this area or deviation from the concept design would require further consultation with the knowledge holder.

9.2.4 Management of impacts

The planning and route selection process have, as far as possible, avoided impacts on Aboriginal archaeological and cultural heritage. Chapter 4 discusses the route selection process that was undertaken for this project, and particularly identifies that Aboriginal heritage was a key consideration in the planning and route selection.

Table 9-10 and 9-11 summarise the management measures to be implemented for identified archaeological and cultural sites. Further detail is provided in the CHAR (see Chapter 9 of Technical Paper 2 (Volume 2)). These measures have been incorporated into the draft statement of commitments in Chapter 11.

Table 9-11 Aboriginal heritage mitigation and management measures

Potential impact	Mitigation and management measures
Pre-construction	
Impacts to Aboriginal heritage.	▪ Prior to the commencement of construction, prepare and implement an Aboriginal heritage management plan as part of the CEMP. ▪ Identify all archaeological sites and cultural heritage places to be protected on heritage site maps so that these areas can be avoided during construction.
Construction	
Impacts to Aboriginal heritage	▪ Manage Aboriginal heritage items in accordance with the CHAR, which identifies mitigation measures, developed in consultation with Aboriginal stakeholders and DECCW. ▪ Prior to the commencement of construction activities, fence all archaeological and cultural sites within the construction site boundary that are not to be impacted in consultation with a qualified archaeologist and/or knowledge holders. ▪ Undertake salvage of impacted sites prior to construction commencing in those areas. ▪ Ensure all construction personnel receive training regarding Aboriginal heritage issues associated with the project.
Impacts to identified cultural places	▪ Consult with the Aboriginal knowledge holder(s) if there are any changes to impacts on identified cultural Places.
Potential for discovery of human skeletal materials	▪ If any skeletal remains are encountered immediately stop any works that would potentially impact the find. Do not recommence works until appropriate clearance is received.

9.3 Noise and vibration

A detailed noise and vibration assessment has been undertaken for the project and is presented below. This is supported by *Technical Paper 3 — Noise and Vibration* (Volume 2).

DGRs	Where addressed
Noise and vibration (including but not limited to):	
Construction noise and vibration, including construction traffic noise and blasting impacts.	Section 9.3.5, Technical Paper 3 (Volume 2)
Operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers.	Section 9.3.4, Technical Paper 3 (Volume 2)
The assessment must take into account the following guidelines as relevant: *Environmental Criteria for Road Traffic Noise* (EPA 1999), *Environmental Noise Management Manual* (RTA 2001), *Draft Noise Control Guidelines, Construction Site Noise* (formerly published as Chapter 171 of the EPA's *Environmental Noise Control Manual*), *Assessing Vibration: A Technical Guideline* (DEC 2006) , and *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC 1990).	Section 9.3.1, Technical Paper 3 (Volume 2)