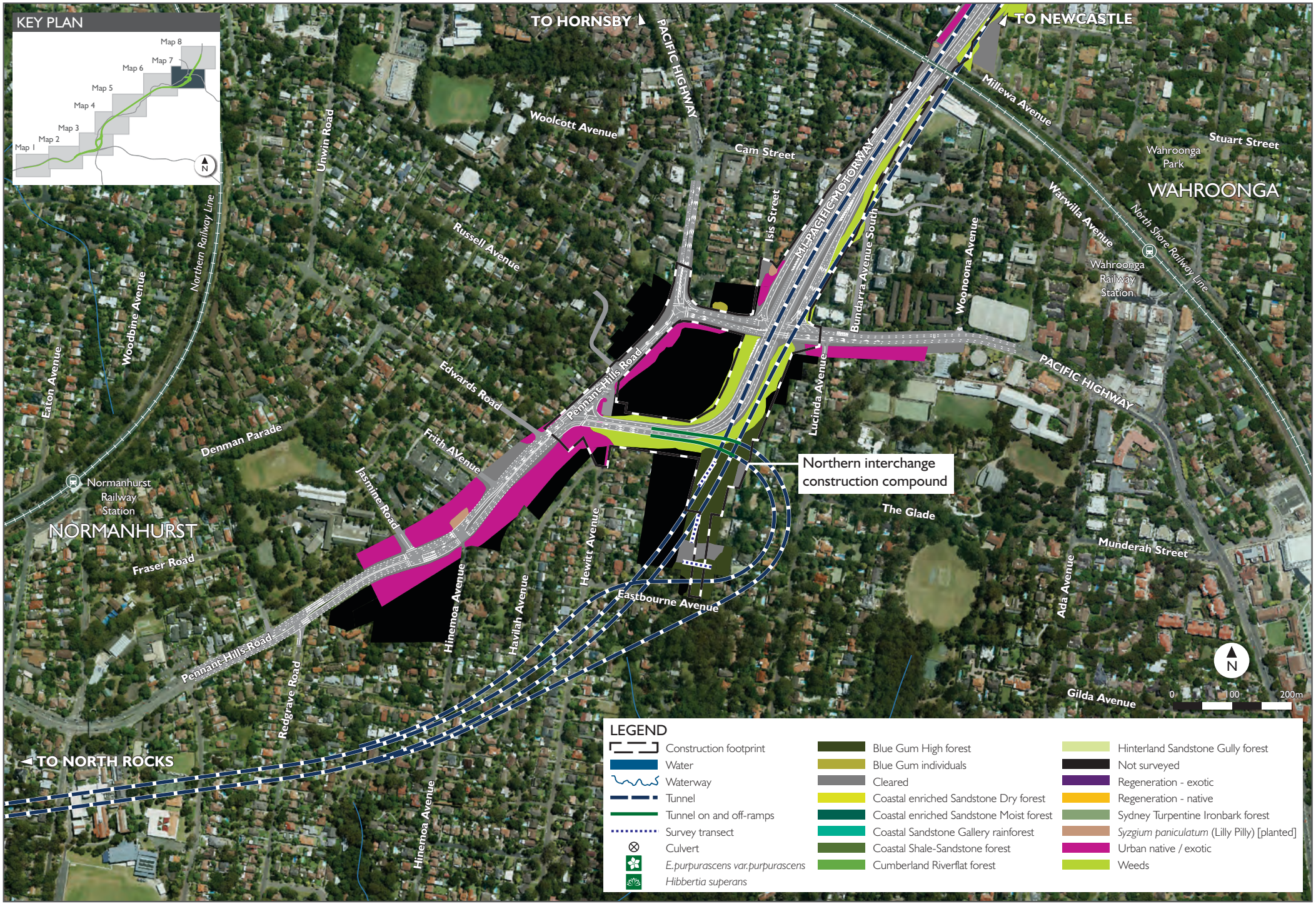

Figure 7-70 Vegetation communities identified - Map 7

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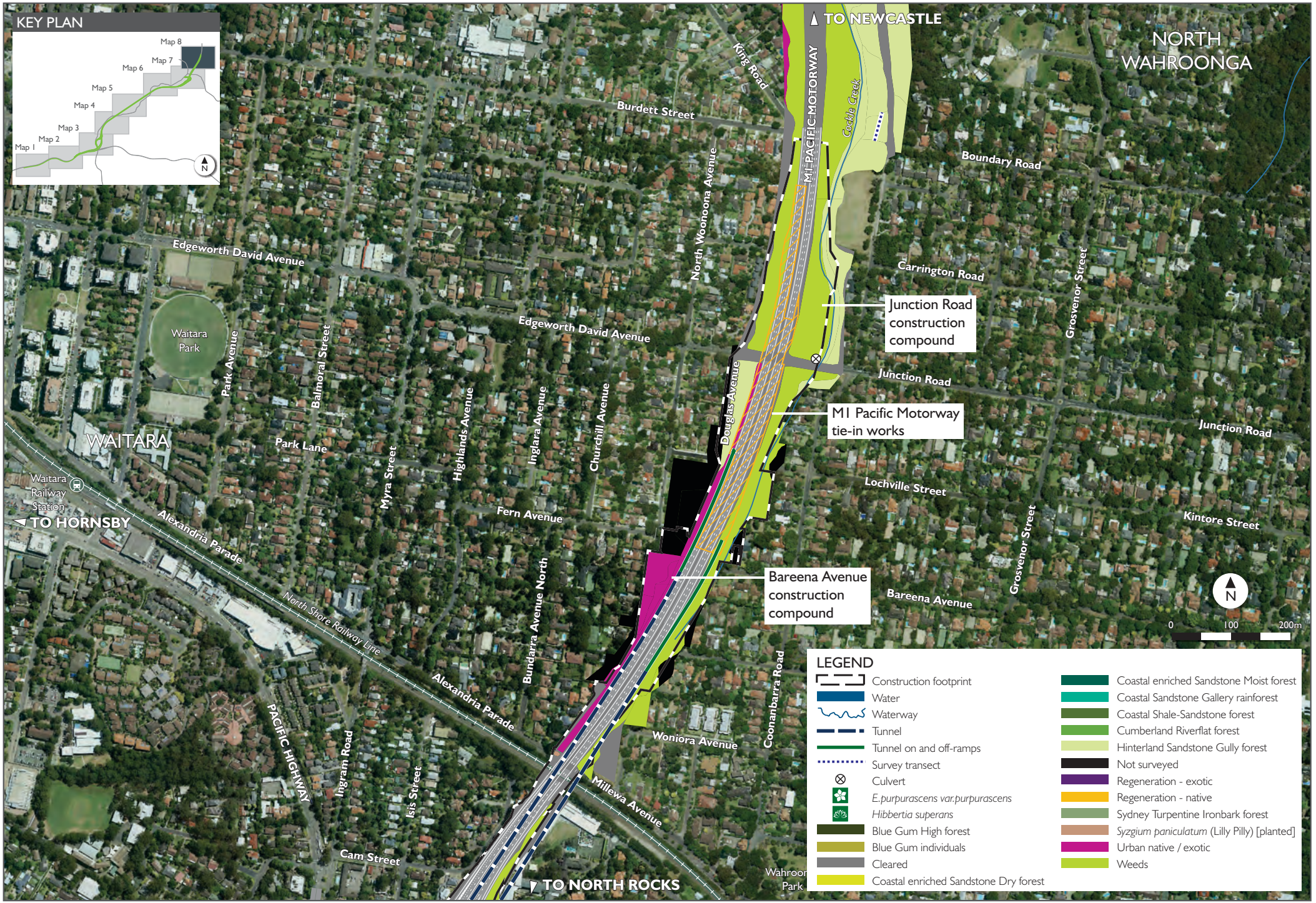

Figure 7-71 Vegetation communities identified - Map 8

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Threatened flora

A database search of the NSW Wildlife Atlas (OEH, 2013a), the Protected Matters database (Department of the Environment, 2013b) and a literature review identified five threatened flora species that have the potential to occur within the biodiversity study area. These threatened flora species, their conservation status and identification records during field surveys for the project are summarised in **Table 7-150**.

Table 7-150 Threatened flora occurring or potentially occurring within the biodiversity study area

Species	TSC Act	EPBC Act	Recorded during field surveys
Callistemon linearifolius (Netted Bottlebrush)	V	-	No
Darwinia biflora	V	V	No
Epacris purpurascens var. purpurascens	V	-	Yes
Hibbertia superans	E	-	Yes
Syzygium paniculatum (Magenta Lilly Pilly)	V	V	Yes

E = endangered, V = vulnerable

Exotic species

Field surveys carried out for the project have identified abundant weeds within the biodiversity study area with some areas containing prolific weed infestations. The most common weeds encountered were:

- *Asparagus aethiopicus* (Asparagus Fern) – listed as noxious in the Hornsby local government area and as a Weed of National Significance.
- *Bidens pilosa* (Cobblers Pegs).
- *Cinnamomum camphora* (Camphor Laurel) – listed as noxious in the Hornsby local government area.
- *Genista monspessulana* (Montpellier Broom) – listed as noxious in the Hornsby local government area and as a Weed of National Significance.
- *Lantana camara* (Lantana) – listed as noxious in the Hornsby local government area and as a Weed of National Significance.
- *Ligustrum lucidum* (Large-leaved Privet) – listed as noxious in the Hornsby local government area.
- *Ligustrum sinense* (Small-leaved Privet) – listed as noxious in the Hornsby local government area.
- *Ochna serrulata* (Mickey Mouse Plant) – listed as noxious in the Hornsby local government area.
- *Rubus fructicosus* aggregate species (Blackberry) – listed as noxious in The Hills and Hornsby local government areas.
- Verbena bonariensis (Purpletop).

A comprehensive list of weeds identified within the biodiversity study area is provided in the technical working paper: biodiversity (**Appendix J**).

Terrestrial fauna

Threatened fauna

A database search of the NSW Wildlife Atlas has identified 20 threatened fauna species, and one endangered population, that have the potential to occur within the biodiversity study area. Fauna species and endangered populations that may be located within the biodiversity study area, and their conservation status, are listed in **Table 7-151**

Table 7-151 Threatened fauna and endangered populations identified as potentially occurring within the biodiversity study area

Species	TSC Act	EPBC Act
Threatened fauna		
Pseudophryne australis (Red-crowned Toadlet)	V	-
Varanus rosenbergi (Rosenberg's Goanna)	V	-
Callocephalon fimbriatum (Gang-gang Cockatoo)	V	-
Calyptorhynchus lathami (Glossy Black-Cockatoo)	V	-
Daphoenositta chrysoptera (Varied Sittella)	V	-
Petroica boodang (Scarlet Robin)	V	-
Petroica phoenicea (Flame Robin)	V	-
Ninox connivens (Barking Owl)	V	-
Ninox strenua (Powerful Owl)	V	-
Tyto novaehollandiae (Masked Owl)	V	-
Cercartetus nanus (Eastern Pygmy-possum)	V	-
Chalinolobus dwyeri (Large-eared Pied Bat)	V	V
Miniopterus australis (Little Bent-wing Bat)	V	-
Miniopterus schreibersii oceanensis (Eastern Bent-wing Bat)	V	-
Myotis macropus (Southern Myotis)	V	-
Falsistrellus tasmaniensis (Eastern False Pipistrelle)	V	-
Mormopterus norfolkensis (Eastern Freetail-bat)	V	-
Pteropus poliocephalus (Grey-headed Flying-Fox)	V	V
Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)	V	-
Scoteanax rueppellii (Greater Broad-nosed Bat)	V	-
Endangered populations		
Callocephalon fimbriatum (Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai local government areas)	E	-

E = endangered, V = vulnerable

No sightings of threatened fauna species or endangered communities occurred during field surveys for the project, however potential habitats for threatened species have been identified. Sightings have occurred during previous surveys within five kilometres of the biodiversity study area of the Gang-gang Cockatoo, Glossy Black-Cockatoo, Eastern Pygmy-possum, Eastern False Pipistrelle, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat and the Greater Broad-nosed Bat.

Wildlife corridors

No regional fauna corridors have been identified within the biodiversity study area, primarily due to the fragmented structure of vegetation in the area. However, local scale wildlife corridors exist along riparian corridors connection to regional parks (refer to **Figure 7-72**), including:

- Cockle Creek (also known as Spring Gully Creek) adjacent to the M1 Pacific Motorway at the top of the catchment of Ku-ring-gai Chase National Park.
- Devlins Creek along the Hills M2 Motorway at the top of the Lane Cove National Park catchment.
- Blue Gum Creek, Darling Mills Creek and Stevenson Creek in Bidjigal Reserve on the upper tributaries of the Parramatta River catchment.

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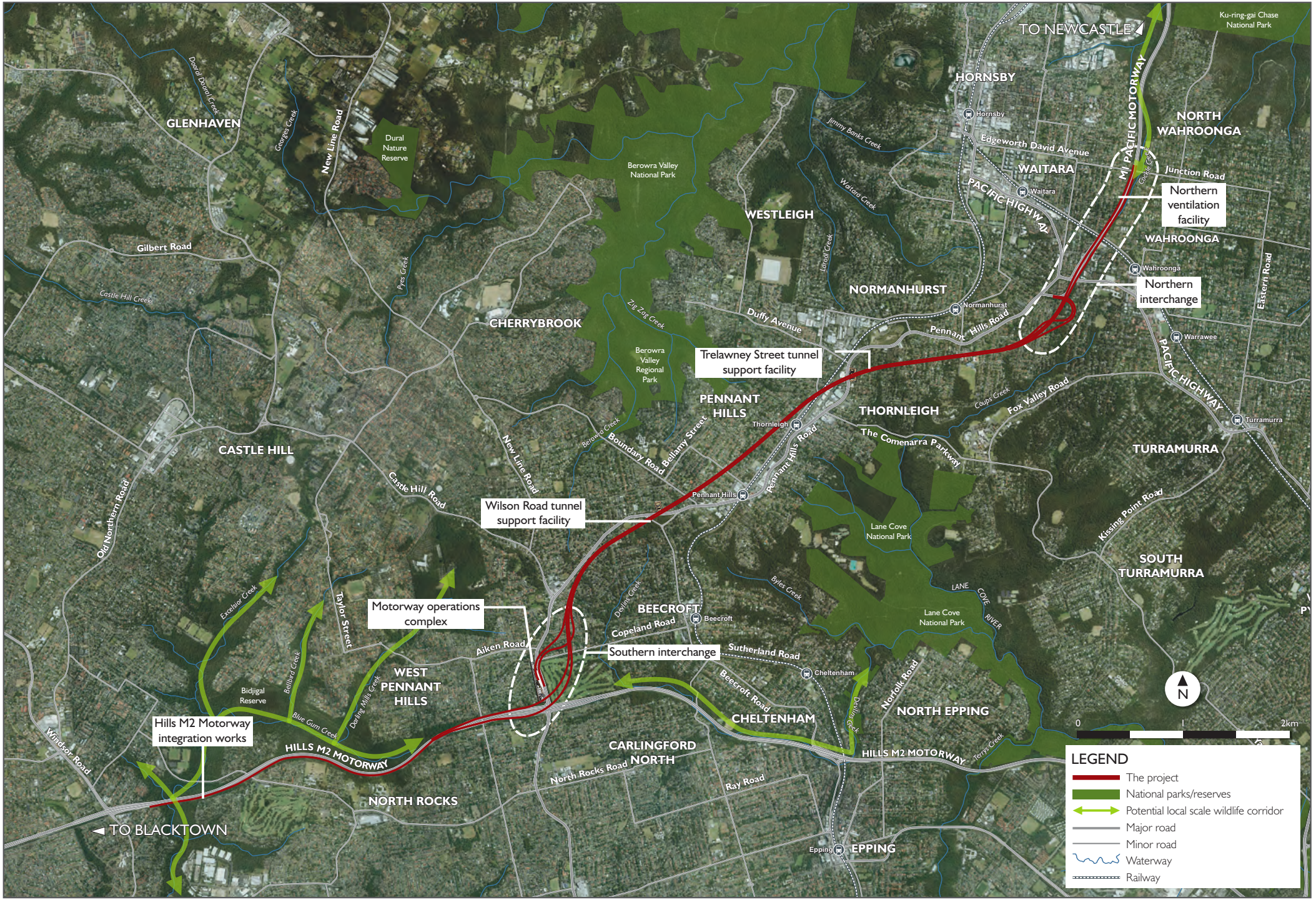

Figure 7-72 Local scale wildlife corridors along riparian areas

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Terrestrial habitats

The following section provides a description of flora and fauna habitats within the biodiversity study area. No critical habitat has been declared for any of the species or ecological communities within the biodiversity study area.

Windsor Road compound (C1)

The vegetation at this site is in a highly urbanised context existing primarily on private properties. Observations from the adjacent roadway and verges indicated that a large proportion of this site is urban native / exotic vegetation.

Southern interchange and the Hills M2 Motorway integration works

The area around Darling Mills Creek to the north of the current Hills M2 Motorway and east to Blue Gum Creek is characterised by a steep landscape with many sandstone outcrops, large hollow bearing trees, small watercourses and several drainage culverts. Each of these features provide potential suitable habitat for a range of fauna.

The vegetation along the Hills M2 Motorway provides connected habitat with Bidjigal Reserve, Munro Reserve and Excelsior Park. Batter slopes grading to noise walls erected along the corridor contain significant weed infestations and generally provide potential habitat in poor condition.

Vegetation in the immediate vicinity of the southern interchange has been modified as part of suburban development, but contains two threatened ecological communities, Blue Gum High Forest and Sydney Turpentine-Ironbark Forest. Both of these communities persist as highly modified remnants. Vegetation along the southern side of the Hills M2 Motorway is a mix of modified native vegetation and areas invaded by exotic species. Where the canopy and understorey component is intact, the condition of vegetation communities is generally good. Areas in poor condition are generally found along riparian areas, including areas of Blue Gum High Forest.

A number of hollow bearing trees have been identified within the study area around the southern interchange and the Hills M2 Motorway integration works. Most of these hollow bearing trees are located around Darling Mills Creek, with a number also located around Lisle Court. These hollow bearing trees provide potential habitat for bats, mammals and diurnal birds. A number of culverts passing under the Hills M2 Motorway may also provide suitable habitat for microbats.

Wilson Road compound (C6) and Trelawney Street compound (C7)

Most of the vegetation at these sites consists of urban native / exotic vegetation contained within planted garden beds. Along the edge of private properties on Wilson Road there are remnant *Eucalyptus saligna* (Sydney Blue Gum) and *Syncarpia glomulifera* (Turpentine) individuals. Vegetation has been identified to be in poor condition with limited habitat value.

Pioneer Avenue compound (C8)

Blue Gum High Forest was mapped at Pioneer Avenue compound in two small areas, in the north-west corner, and along the eastern boundary adjoining the railway line. The remainder of the site is largely composed of weeds and exotics.

The site contains a number of hollow bearing trees providing potential habitat for bats, mammals and diurnal birds. The disused buildings on the site may also provide suitable habitat for microbats.

Northern interchange

The worst case footprint of the northern interchange contains:

- Linear strips of highly modified native Hinterland Sandstone Gully Forest.
- Urban street plantings.
- Large linear areas of landscaping leading to batter slopes grading up to noise walls located along the M1 Pacific Motorway corridor.
- A small area of modified Blue Gum High Forest to the south of the M1 Pacific Motorway / Pennant Hills Road connector.

The condition of native vegetation communities varies. Where the canopy and understorey component are intact, vegetation condition is good. This is largely in the drier sclerophyll forests around the northern extent of the northern interchange footprint. Vegetation in poor condition is generally found along riparian areas, in areas of Blue Gum High Forest or in areas that have been subject to previous filling and planting.

Most native vegetation exists between the noise walls located along the M1 Pacific Motorway corridor and suburban development consisting predominantly of residential housing. There is little connection to other tracts of remnant native vegetation in the area with the exception of Cockle Creek, which joins vegetation in Ku-ring-gai Chase National Park to the north. There is a small, narrow vegetated corridor which connects the highly modified Blue Gum High Forest with the Glade and Loggers Retreat in Wahroonga and eventually Brown Reserve at North Epping.

There are few habitat features present, however a number of hollow bearing trees are present along the northern interchange with the greatest concentration of hollow bearing trees in the Blue Gum High Forest located in the south of this part of the study area. Habitat predominantly exists for bats, however potential habitat for mammals and diurnal birds has also been identified. One culvert passing under Junction Road may provide suitable habitat for microbats.

Aquatic flora and fauna

Seven watercourses traverse or are in the vicinity of the biodiversity study area:

- Darling Mills Creek (crossed by the Hills M2 Motorway integration works).
- Blue Gum Creek (adjacent to the Hills M2 Motorway integration works).
- Devlins Creek (around 4.5 kilometres from the southern interchange).
- Cockle Creek (adjacent to the M1 Pacific Motorway tie-in works), also known as Spring Gully Creek.
- Tedbury Creek (downstream of the Wilson Road compound (C6)).

- A tributary of the Lane Cove River, referred to as Butterfield Street Creek for the purpose of this assessment (downstream of the Trelawney Street compound (C7)).
- Coups Creek and two of its tributaries (downstream of the northern interchange).

The condition and aquatic habitats for each creek are outlined in the following sections. Further details of local and regional hydrology are provided in **Section 7.9** (Surface water).

There are no wetlands protected under *State Environmental Planning Policy No 14 – Coastal Wetlands* (SEPP 14) in the vicinity of the biodiversity study area.

In addition to natural watercourses, constructed detention basins along the Hills M2 Motorway provide potential habitat for aquatic flora and fauna. The primary purpose of these basins is to slow stormwater flows to minimise water pollution and impacts to the hydrology of receiving waters. These basins also support emergent aquatic native plants providing potential wildlife habitat. Emergent aquatic plants currently found growing in the detention basins include *Eleocharis sphacelata* (Tall Spike Rush), *Bolboschoenus fluviatilis* (Tall Club-sedge), and *Typha orientalis* (Broadleaf Cumbungi). Four frog species have been previously recorded within the detention basins: *Litoria peronei* (Peron's Tree Frog), *Litoria fallax* (Eastern Dwarf Tree Frog), *Limnodynastes peronii* (Striped Marsh Frog) and *Crinia signifera* (Common Eastern Froglet). As the detention basins are isolated they are unlikely to be inhabited by fish though other fauna may be found in these locations.

Darling Mills Creek

The sandstone riparian scrub vegetation occurring along the creek is highly modified as a result of altered flow regimes, increased nutrients and weed invasion. The creek flows through vegetated areas where disturbances such as weed invasion, services installation (sewer) and bushwalking trails have caused moderate changes to the creek line. Bed sediments are composed of cobble and gravel upstream of the Hills M2 Motorway and sand deposited over cobble downstream. The creek is generally slow flowing with pools linked by occasional riffles or runs. Fish habitat is minimal in the upper reaches but increases downstream.

Blue Gum Creek

Blue Gum Creek is a relatively narrow and shallow first order stream on the eastern side of the Hills M2 Motorway. The creek originates at the north-west corner of Oakes Road and the Hills M2 Motorway and flows for around 1.5 kilometres before entering Darling Mills Creek. The creek is characterised by pools with occasional riffle / run sequences. Substrate in the upper reaches is dominated by boulders and pebbles while downstream it is mostly cobble and gravel. The creek is one to three metres wide and around ten to 20 centimetres deep. Aquatic vegetation has low diversity and the riparian vegetation is composed largely of weeds with some regeneration work apparent. Fish habitat is low in the creek due to an absence of deep pools.

Devlins Creek

Devlins Creek is a tributary of Lane Cove River. Riparian areas along the creek have a history of active regeneration activities and are an important focus of local public recreation. Riparian vegetation provides habitat connectivity and potential wildlife corridors between the Lane Cove National Park and regional bushland reserves.

Riparian vegetation associated with Devlins Creek is in moderate condition with a high potential for restoration. Previous investigations of the aquatic habitat of the creek indicate an aquatic environment in moderate condition.

Cockle Creek

Cockle Creek flows into Ku-ring-gai Chase National Park. The upper section of the creek would be located within the worst case footprint of the M1 Pacific Highway tie-in works, between residential development and the M1 Pacific Motorway. The creek is heavily weed infested.

The section of the creek within the worst case M1 Pacific Highway tie-in works disturbance footprint contains no aquatic assemblages (macrophytes or fringing aquatic vegetation), is in poor condition and unable to support fish life. However, the upper sections of the tributaries of Cockle Creek have been identified as potential *Pseudophryne australis* (Red-crowned Toadlet) habitat. Habitat availability varies along the length of the creek with complexity increasing downstream. Fish, frog and bird habitat quality also improves downstream.

Tedbury Creek

Tedbury Creek is located downstream of the Wilson Road compound (C6). The creek flows into Zig Zag Creek which joins Berowra Creek. Erosion, undercutting of banks and weed invasion are all common along the creek and the dominant substrate of the creek is silt. The quality of the creek changes significantly where it drops down a series of rocky falls with few weeds and riparian vegetation in good condition. Parts of the creek were dry during ecological field surveys. One large pool with potential for fish habitat has been identified in the lower reaches of the creek.

Butterfield Street Creek

This creek is an unnamed tributary of the Lane Cove River south of the Trelawney Street compound (C7) (referred to in this assessment as Butterfield Street Creek). The creek is around 600 metres long and has been moderately modified. The creek is unlikely to contain native fish habitat, but its upper reaches may provide moderate quality frog habitat.

Coups Creek

Coups Creek and two of its unnamed tributaries would be located south of the northern interchange. Coups Creek is relatively long and eventually flows into the Lane Cove River. The creek is moderately modified and has bedrock and cobble as the primary substrate. Fish habitat is patchy and restricted to small pools. Some frog habitat has been identified.

Groundwater dependent ecosystems

Shallow groundwater can support riparian vegetation either permanently or seasonally. Groundwater needs to be sufficiently shallow to support vegetation where root systems of vegetation communities are able to access groundwater.

Five potential groundwater dependent ecosystems have been identified within 200 metres of the biodiversity study area:

- Hinterland Sandstone Gully Forest.
- Coastal Sandstone Ridgetop Woodland.
- Sydney Turpentine Ironbark Forest.
- Sandstone Riparian Scrub.
- Sydney Hinterland Transition Woodland.

Of these communities, only three communities in areas along the Hills M2 Motorway have been identified as having high potential for groundwater dependence (Hinterland Sandstone Gully Forest, Sandstone Riparian Scrub and Sydney Hinterland Transition Woodland). Potential groundwater dependent ecosystems have not been identified elsewhere within or in proximity to the worst case project disturbance footprint, including above and around the main alignment tunnels.

An existing groundwater monitoring bore (GW110252, located near the intersection of Windsor Road and Windemere Road) to a depth of eight metres below ground level suggests the presence of a superficial aquifer near Northmead Gully. This aquifer may extend eastward to Darling Mills Creek and is likely to be the source of groundwater for potential groundwater dependent ecosystems in this area.

7.6.3 Assessment of potential impacts

Potential impacts to terrestrial and aquatic flora and fauna within the biodiversity study area during the construction and operation of the project include:

- Impacts on vegetation communities, habitats and threatened species.
- Impacts on threatened flora.
- Impacts on threatened fauna.
- Impacts on aquatic flora and fauna.
- Impacts on migratory and marine species
- Spread of weeds.
- Impacts on hydrology and aquatic ecology.
- Introduction and spread of pathogens.
- Animal pests.
- Fauna injury and mortality.
- Wildlife connectivity and habitat fragmentation.
- Impacts on groundwater dependent ecosystems.
- Increases in bushfire occurrence.
- Noise, vibration and lighting impacts.
- Impacts on relevant key threatening processes.

Construction

The preferred tender design aimed to avoid impact to known area of sensitivity, eg the Blue Gum High Forest around Brickpit Park and Kenley Park, however some impacts on areas of ecological sensitivity were unavoidable.

Impacts on vegetation communities, habitats and threatened ecological communities

Clearance of vegetation and loss of habitat would be unavoidable due to the required footprint of the project. Notwithstanding, opportunities to avoid and minimise the extent of vegetation clearing would continue to be considered during detailed design of the project. For the purpose of this assessment, a worst case construction disturbance footprint has been assumed.

Impacts to terrestrial vegetation communities and habitats include:

- Clearance of around 21 hectares of vegetation, including both native and exotic species.
- Clearance of around six hectares of native vegetation.
- Clearance of around three hectares of Blue Gum High Forest and 0.1 hectares of Sydney Turpentine-Ironbark Forest (both listed as EECs under the TSC Act).

Table 7-152 provides a detailed breakdown of vegetation that would be directly impacted directly by the construction footprint.

Table 7-152 Vegetation potentially impacted by the project (hectares)

Vegetation community	Condition	Windsor Road compound (C1)	Hills M2 Motorway integration works	Southern interchange	Wilson Road compound (C6)	Trelawney Street compound (C7)	Pioneer Avenue compound (C8)	Northern interchange	Total
Blue Gum High Forest	Moderate	-	-	0.37	-	-	-	-	0.37
	Poor	-	1.20	0.10	-	-	-	1.14	2.44
Blue Gum individuals	Low	-	0.01	-	0.07	-	-	-	0.08
Coastal Enriched Sandstone Dry Forest	Good	-	0.01	-	-	-	-	-	0.01
Coastal Enriched Sandstone Moist Forest	Good	-	0.15	-	-	-	-	-	0.15
Coastal Sandstone Gallery Rainforest	Moderate	-	0.03	-	-	-	-	-	0.03
Coastal Shale-Sandstone Forest	Good	-	0.55	-	-	-	-	-	0.55
	Moderate	-	0.30	-	-	-	-	-	0.30
	Poor	-	0.85	-	-	-	-	-	0.85
Hinterland Sandstone Gully Forest	Poor	-	-	-	-	-	-	0.72	0.72
Sydney Turpentine-Ironbark Forest	Poor	-	-	-	0.10	-	-	-	0.10
Syzygium paniculatum (Lilly Pilly) (planted)	Poor	-	0.02	0.02	-	-	-	0.03	0.07
Regeneration – native	Moderate	-	0.19	-	-	-	-	-	0.19
Total native vegetation		**0**	**3.31**	**0.49**	**0.17**	**0**	**0**	**1.89**	**5.86**
Regeneration – exotic	Low	-	0.56	-	-	-	-	-	0.56
Urban native / exotic	Low	-	1.58	3.01	-	-	-	1.77	6.36
Weeds and exotics	Low	0.04	0.95	0.09	-	-	0.46	5.87	7.41
Not surveyed	N/A	-	0.94	2.35	-	-	-	0.74	4.03
Cleared	N/A	0.59	12.64	7.83	0.61	0.93	1.41	10.44	34.45
Total construction footprint (worst case)		**0.63**	**19.98**	**13.77**	**0.78**	**0.93**	**1.87**	**20.71**	**58.68**

Blue Gum High Forest community

The project would remove areas of Blue Gum High Forest community (as defined under the TSC Act) near the northern interchange, the southern interchange and the Hills M2 Motorway integration works area. Worst case vegetation removal requirements are quantified in **Table 7-152**.

A small number of remnant Blue Gum individuals have also been identified at the Wilson Road compound (C7). These areas of vegetation meet the definition of Blue Gum High Forest community under the TSC Act and would require removal as part of the project.

As noted in **Section 7.6.2**, none of the Blue Gum High Forest patches that have been identified in the biodiversity study area meet the definition of this community under the EPBC Act. This is because of the size of the Blue Gum High Forest patches and / or the absence of a native understorey. Further details regarding the definition of Blue Gum High Forest under the EPBC Act and the TSC Act and the condition of the Blue Gum High Forest found within the disturbance area is provided in the technical working paper: biodiversity in **Appendix J**.

It is estimated that around 170 hectares of Blue Gum High Forest (as defined under the TSC Act) (Tozer, 2003) remains in existence across northern Sydney. The project is expected to require clearing of up to 2.81 hectares of Blue Gum High Forest (not including an estimated 0.08 hectares of Blue Gum individuals), which is equivalent to 1.7 per cent of the estimated remaining area of this community.

A detailed assessment of the significance of clearing up to 2.81 hectares of Blue Gum High Forest community is presented in the technical working paper: biodiversity (**Appendix J**). The assessment concludes that despite the provision of mitigation measures, there is likely to be a significant impact on TSC Act listed Blue Gum High Forest as a result of the project. This conclusion reflects the limited remaining areas of this community and its status as a critically endangered ecological community under the TSC Act. As a result, biodiversity offsets would be required (refer to **Section 7.6.4** for further details).

Sydney Turpentine-Ironbark Forest community

Sydney Turpentine-Ironbark Forest community has been found adjacent to the southern interchange and within the Wilson Road compound (C7). These patches meet the TSC Act definition of the community, but not the definition of the community under the EPBC Act.

The patch adjacent to the southern interchange area has been avoided through the design of the project. The small patch identified at the Wilson Road compound (C7) comprises scattered individual trees with no native understorey or ground cover. The project would require the removal of this patch totalling 0.1 hectares.

A significance assessment has been conducted for potential impacts on the Sydney Turpentine-Ironbark Forest community (refer to technical working paper: biodiversity, **Appendix J**). The assessment concludes that the project is unlikely to significantly impact on this community.

Impacts on threatened flora

Five threatened flora species have the potential to occur within the study area, however only three have been recorded during field surveys. **Table 7-153** provides the results of significance assessments undertaken for these species. Further details of the significance assessments are provided in **Appendix J**.

Table 7-153 Threatened flora recorded within the biodiversity study area

Species	TSC Act	EPBC Act	Comments	Potential significant impact
Epacris purpurascens var. purpurascens	V	-	One hundred and eighty *Epacris purpurascens* var. *purpurascens* individuals have been previously recorded in the area in and around the Hills M2 Motorway integration works (Cumberland Ecology, 2012). A total of 87 of these individuals have been confirmed through field surveys conducted for the project. It is expected that up to 106 individuals would require removal as a consequence of the project. This equates to around 59 per cent of the previously identified population in the locality. This represents a potential worst case loss of *Epacris purpurascens* var. *purpurascens*, noting that detailed design of the project would aim to avoid or minimise individuals where possible. A significance assessment has been undertaken for this species, which concludes that there is likely to be a significant impact on this species. This conclusion has been based on the extent of loss of the local population of previously recorded *Epacris purpurascens* var. *purpurascens* individuals. Further field surveys would be carried out prior to the commencement of construction, to confirm the actual extent of clearing required and the likely significance of the impact on the species.	Yes
Hibbertia superans	E	-	A population of four *Hibbertia superans* individuals has been identified on the northern side of the Hills M2 Motorway integration works. These individuals lie within 30 metres of (but outside) the expected construction disturbance footprint for the Hills M2 Motorway integration works. Further surveys would be carried out prior to the commencement of construction to confirm the extent of the local population and potential impacts on this species.	No
Syzygium paniculatum (Magenta Lilly Pilly)	V	V	The project would result in the clearance of three of the four patches identified within the study area. However, the individuals found are all planted and this species does not naturally occur within the Sydney basin.	No

Species	TSC Act	EPBC Act	Comments	Potential significant impact
Callistemon linearifolius (Netted Bottlebrush)	V		No individual of this species have been identified in the study area, however suitable habitat was found within the construction footprint of the Hills M2 Motorway integration works. A significance assessment has been undertaken for this species, which concluded and concluded that the project is unlikely to result in a significant impact because there were no individuals detected within the construction footprint and the impacts to potential habitat were minimal, given the extent of potential habitat existing outside the construction footprint.	No
Darwinia biflora	V	V	No individual of this species have been identified in the study area, however suitable habitat was found within the study area of the Hills M2 Motorway integration works, but outside the construction footprint. A significance assessment has been undertaken for this species, which concluded that that the proposal is unlikely to result in a significant impact given that the species was not detected within the construction footprint and that potentially suitable habitat for the species within the study area occurs beyond the construction footprint.	No

E = endangered, V = vulnerable

Impacts on threatened fauna

Twenty threatened fauna species have the potential to occur within the biodiversity study area. **Table 7-154** provides the results of the significance assessments undertaken for these species. Further details of the significance assessments are provided in the technical working paper: biodiversity (**Appendix J)**.

Table 7-154 Threatened fauna recorded within the biodiversity study area

Species	Comments	Potential significant impact
Pseudophryne australis (Red-crowned Toadlet) TSC Act – vulnerable	Potential habitat for the Red-crowned Toadlet has been identified during the field survey within tributaries of Cockle Creek at the northernmost extent of the project. These tributaries are downstream outside of the construction footprint of the project. However, there is potential for these tributaries to be indirectly affected variations in runoff and movement of weed propagules. These potential impacts would be mitigated through effective management of erosion and sedimentation, and avoidance and management of potential avenues for weed invasion. Potential impacts of the project on this species are unlikely to be significant because the habitat is outside the construction footprint and no potential breeding or foraging habitat would be impacted.	No
Varanus rosenbergii (Rosenberg's Goanna) TSC Act – vulnerable	No Rosenberg's Goanna individuals were found during field surveys. However, there is suitable habitat for the species along the Hills M2 Motorway integration works in the vicinity of Darling Mills, Stevenson and Blue Gum Creeks. Critical breeding habitat features such as termite mounds have not been identified in these areas. The project is unlikely to have a significant impact on the Rosenberg's Goanna because: • It would not impact on suitable breeding habitat. • There is ample alternative foraging habitat nearby. • There would be no impact on the connectivity of and between potential habitat areas.	No
Callocephalon fimbriatum (Gang-gang Cockatoo) TSC Act – vulnerable Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas TSC Act – endangered	Potential foraging and breeding habitat for the Gang-gang Cockatoo has been identified within the disturbance footprints of the Hills M2 Motorway integration works and the northern interchange. The extent of direct disturbance of potential habitat for this species would be small with respect to the area of similar habitat available within the locality. This, coupled with the nomadic patterns of the species, suggests that habitat to be removed by the project would not result in a significant impact to this species.	No

Species	Comments	Potential significant impact
Calyptorhynchus lathami (Glossy Black-Cockatoo) TSC Act – vulnerable	Small patches of *Allocasuarina* have been identified along the Hills M2 Motorway integration works, which may provide foraging habitat for the Glossy Black-Cockatoo. Hollow bearing trees have also been identified in this area, which may provide breeding habitat. No evidence of the species utilising this habitat has been discovered during field surveys. The area of potential habitat to be cleared is small relative to the potential habitat remaining in vegetation adjacent to the disturbance footprint of the Hills M2 Motorway integration works. Therefore, the project is unlikely to have a significant impact on this species.	No
Daphoenositta chrysoptera (Varied Sittella) TSC Act – vulnerable	Some foraging habitat for this species is present within the biodiversity study area, however no evidence of the species utilising this habitat has been identified. The area of potential habitat to be cleared is small relative to the potential habitat remaining in vegetation adjacent to the disturbance footprint of the Hills M2 Motorway integration works. Therefore, the project is unlikely to have a significant impact on this species.	No
Petroica boodang (Scarlet Robin) TSC Act – vulnerable	Some foraging habitat for this species is present within the biodiversity study area, however no evidence of the species utilising this habitat has been identified. The area of potential habitat to be cleared is small relative to the potential habitat remaining in vegetation adjacent to the disturbance footprint of the Hills M2 Motorway integration works. Therefore, the project is unlikely to have a significant impact on this species.	No
Petroica phoenicea (Flame Robin) TSC Act – vulnerable	Some foraging habitat for this species is present within the biodiversity study area, however no evidence of the species utilising this habitat has been identified. The area of potential habitat to be cleared is small relative to the potential habitat remaining in vegetation adjacent to the disturbance footprint of the Hills M2 Motorway integration works. Therefore, the project is unlikely to have a significant impact on this species.	No

Species	Comments	Potential significant impact
Ninox connivens (Barking Owl) TSC Act – vulnerable	Vegetation clearing required for the project may reduce potential foraging and roosting / breeding habitat for the Barking Owl. Loss of foraging habitat has the potential to reduce the availability of prey species within a mating pair's territory, which may force individuals to travel greater distances during hunting. While the project would result in the removal of potential foraging habitat for the Barking Owl, the project has avoided trees containing large hollows and areas of high quality foraging habitat. Tree hollows with a diameter greater than 300 millimetres constitute potential primary (breeding) habitat for the Barking Owl. The greatest concentration of hollow bearing trees within the biodiversity study area has been identified along the Hills M2 Motorway integration works and at the northern interchange amongst Blue Gum High Forest. All of the hollows of suitable size for viable breeding habitat would be retained. No evidence of nesting by Barking Owls was identified during field surveys. It is unlikely that the species would breed within the biodiversity study area, given the landscape is highly fragmented and disturbed and that the range of the species has contracted considerably in NSW, so that it is rarely found east of the Great Dividing Range.	No
Ninox strenua (Powerful Owl) TSC Act – vulnerable	Vegetation clearing required for the project may reduce potential foraging and roosting/ breeding habitat for the Powerful Owl. Tree hollows with a diameter greater than 300 millimetres constitute potential primary (breeding) habitat for the Powerful Owl. Removal of such habitat may impact the lifecycle of the species by reducing the availability of breeding habitat, which could impact on species fecundity (ability to reproduce) in the local area. The greatest concentration of hollow bearing trees within the biodiversity study area has been identified along the Hills M2 Motorway integration works and at the northern interchange amongst Blue Gum High Forest. All of the hollows of suitable size for viable breeding habitat would be retained. While the project would result in the removal of potential foraging habitat for the Powerful Owl, the project would retain trees containing large hollows and areas of high quality foraging habitat.	No

Species	Comments	Potential significant impact
Tyto novaehollandiae (Masked Owl) TSC Act – vulnerable	There is a lack of breeding records of this species south of the Hawkesbury River and records of this species are sparse in the northern Sydney region in general. As a result, this species is unlikely to rely on vegetation to be cleared for the project for breeding. The project may impact on foraging habitat, but is unlikely to impact on breeding habitat.	No
Cercartetus nanus (Eastern Pygmy-possum) TSC Act – vulnerable	There is limited high quality habitat available for the Eastern Pygmy-possum within the expected construction footprint of the project and only a small amount of the potential habitat available in the biodiversity study area would be cleared.	No
Predominantly cave-roosting bats *Chalinolobus dwyeri* (Large-eared Pied Bat) TSC Act – vulnerable EPBC Act – vulnerable *Miniopterus australis* (Little Bent-wing Bat) TSC Act – vulnerable *Miniopterus schreibersii* (Eastern Bent-wing Bat) TSC Act – vulnerable *Myotis macropus* (Southern Myotis) TSC Act – vulnerable	The following species of bats have been grouped given their similar habitats and the life cycle requirements of the species: • *Chalinolobus dwyeri* (Large-eared Pied Bat). • *Miniopterus australis* (Little Bent-wing Bat). • *Miniopterus schreibersii* (Eastern Bent-wing Bat). • *Myotis macropus* (Southern Myotis). Vegetation clearing required for the project, construction works affecting culverts, and demolition of disused buildings at the Pioneer Avenue compound (C8) may reduce potential foraging, roosting and breeding habitat for the Eastern Bent-wing Bat, Large-eared Pied Bat and Southern Myotis. Culvert works may also affect existing individuals if present in culverts and drainage structures. However, potential impacts are unlikely to be significant subject to the implementation of the mitigation measures outlined in **Section 7.6.4**. These measures include monitoring potential roost sites, establishing alternative habitat areas and maintaining appropriate exclusion zones and managing night works through the breeding and lactation period.	No

Species	Comments	Potential significant impact
Predominantly tree-roosting bats *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) TSC Act – vulnerable *Mormopterus nortfolkensis* (Eastern Freetail-bat) TSC Act – vulnerable *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) TSC Act – vulnerable *Scoteanax rueppelli* (Greater Broad-nosed Bat) TSC Act – vulnerable	The following species of bats have been grouped given their similar habitats and the life cycle requirements of the species: • *Falsistrellus tasmaniensis* (Eastern False Pipistrelle). • *Mormopterus nortfolkensis* (Eastern Freetail-bat). • *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat). • *Scoteanax rueppelli* (Greater Broad-nosed Bat). The biodiversity study area contains suitable hollows for tree-roosting bats and provides foraging habitats at the northern interchange, southern interchange and around Hills M2 Motorway integration works. Hollow bearing trees are an important component in the lifecycle of these species. Vegetation clearing required for the project may result in the removal of suitable breeding tree hollows or the removal / degradation of foraging habitat for all of these tree-roosting bats. These species are highly mobile and may forage in adjacent vegetation. Given the small area of vegetation to be removed relative to the extent of vegetation adjacent to the expected construction footprint, particularly around the Hills M2 Motorway integration works, the project is unlikely to have a significant impact on the foraging habitat for these species. Additionally, mitigation measures listed in **Section 7.6.4** would be implemented including pre-clearance surveys, tree clearing protocols, installation of nest boxes and potential retention of hollow bearing trees.	No
Pteropus poliocephalus (Grey-headed Flying-Fox) TSC Act – vulnerable EPBC Act – vulnerable	The worst case construction footprint would not disturb any known roosting camps for this species. Potential foraging habitat would be lost through clearing of vegetation associated with the Hills M2 Motorway integration works, the southern interchange and the northern interchange. While the vegetation at these sites may be potential foraging habitat, the extent of clearing required for the project would be minimal compared with other potential foraging habitat in the region.	No

Impacts on migratory and marine species

Based on database searches and literature reviews, several migratory species protected under the EPBC Act and the international agreements of China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) have been identified as having been previously recorded within ten kilometres of the biodiversity study area. Of the species that have been identified, only *Anthochaera phrygia* (Regent Honeyeater) and *Lathamus discolor* (Swift Parrot) have potential to utilise habitat within the biodiversity study area.

The Regent Honeyeater may potentially fly over the biodiversity study area. The box-ironbark eucalypt woodland habitat for this species is limited within the biodiversity study area, and it is therefore unlikely that the species would rely on this habitat.

Similarly, while habitat exists for the Swift Parrot in and around the Hills M2 Motorway integration works, the limited extent of this habitat means that it is unlikely to be relied upon by the species.

No other listed migratory or marine species are likely to utilise the biodiversity study area as no suitable habitat for these species exists.

Impacts to hydrology and aquatic ecology

The project has the potential to result in temporary impacts to hydrology due to the following construction activities:

- Dewatering, treatment and discharge of groundwater during construction of the main alignment tunnels, on-ramps and off-ramps.
- An increase in runoff during construction as a result of increased paved areas.
- Changes to current flow regimes caused by alterations to existing detention basins and culverts, and the installation of new culverts for the Hills M2 Motorway integration works and the M1 Pacific Motorway tie-in works.
- The extension to existing watercourse crossings that may require partial removal of riparian vegetation.
- Construction of a temporary vehicular crossing by piping or box culvert of a section of Cockle Creek at the Junction Road compound (C11).

Captured groundwater would be pumped to four water treatment plants located at the tunnel construction support sites. The groundwater would be treated prior to discharge to four local waterways via the existing stormwater system:

- Blue Gum Creek, from the southern interchange compound (C5).
- Tedbury Creek, from the Wilson Road compound (C6).
- Butterfield Street Creek, from the Trelawney Street compound (C7).
- Coups Creek, from the northern interchange compound (C9).

Groundwater collected during tunnel works would be treated prior to discharge to meet the requirements of an environment protection licence issues for the project which is expected to be consistent with the 80 per cent protection level criteria as specified in the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (ANZECC & ARMCANZ, 2000). Further details regarding the treatment and discharge of captured groundwater is provided in **Section 7.9** (Surface water).

An increase in paved areas and tunnel water discharge to local waterways may result in increased erosion and sedimentation around construction sites. Temporary controls would be implemented to manage erosion and sedimentation from the project and to maintain water quality within and adjacent to construction zones. These controls are detailed in **Section 7.8** (Hydrogeology and soils) and **Section 7.9** (Surface water).

The condition of aquatic habitats downstream of the project varies from slightly modified to substantially modified. Upper reaches of watercourses are generally more heavily disturbed than further downstream. Potential impacts as a result of construction works may include:

- Encroachment of construction works into riparian areas.
- Loss of riparian habitat.
- Groundwater discharge.
- Weed invasion.
- Polluted surface water runoff.
- Increased velocity of surface water runoff.
- Surface erosion, increased turbidity and sedimentation.

Potential impacts to aquatic fauna in the upper reaches of watercourses in proximity to construction areas are likely to be limited given the already degraded condition of these environments and the lack of habitat. Higher quality environments further downstream could be affected by:

- Increased surface water volumes and velocities, which may contribute to bank erosion and sedimentation of pools and interstitial habitat between cobble / pebble substrate.
- Transport of weeds and nutrients, which may increase the risk of algal blooms.

The potential impacts may reduce the availability or desirability of habitat for macroinvertebrates.

These impacts would be avoided by slowing discharge flows, removing sediment and nutrients prior to discharge, and stabilising banks where necessary. Further information regarding these mitigation measures is provided in **Section 7.8** (Hydrogeology and soils) and **Section 7.9** (Surface water).

Spread of weeds

Weeds are abundant within the biodiversity study area with some areas containing prolific weed infestations. Given the high presence of weeds, it is likely that vegetation disturbance would create conditions conducive to the spread and intensification of weeds. If not appropriately mitigated and managed, this may have a flow on effect to native flora and fauna by reducing the quality of available habitats, introducing competition for resources and altering the structure and composition of vegetation communities.

The implementation of the mitigation measures outlined in **Section 7.6.4** would manage the potential for the spread of weeds from construction activities.

Pathogens

Several pathogens of concern occur within NSW and have the potential to impact on native flora and fauna. Projects that involve the movement of equipment over large areas are of particular concern given the high potential for pathogen spread.

Potential pathogens of concern within the biodiversity study area include:

- *Uredo rangelli* (Myrtle rust).
- *Batrachochytrium dendrobatidis* (Chytrid fungus).
- *Phytophthora cinnamomi* (Phytophthora).

Myrtle rust was positively identified in the Hills M2 Motorway Upgrade project, although the areas of infected individuals are outside the construction footprint of this project. Myrtle rust may affect native vegetation such as bottlebrush (*Callistemon* species), tea tree (*Melaleuca* species) and eucalyptus (*Eucalyptus* species).

Chytrid fungus is of particular concern for amphibian species, including in areas around the northern interchange in potential habitats for the threatened *Pseudophryne australis* (Red-crowned Toadlet). If not effectively managed, there is a risk that the fungus may be introduced into the species' habitat through contamination of water bodies and improper handling of frogs.

Phytophthora has not been previously identified in the biodiversity study area, but has the potential to be spread over large areas by water, vehicle and machinery movement as well as human and animal movement. Once introduced, Phytophthora represents a significant threat to flora, including native vegetation, through root rot.

Given that no pathogens have been identified within the areas expected to be directly disturbed by the project, the mitigation focus would be on management and prevention of introduction from external sources. Mitigation measures to achieve this outcome are provided in **Section 7.6.4**.

Animal pests

The highly disturbed and suburban setting of the biodiversity study area means that there is potential for common pest species to be presented. Likely pests include *Vulpes vulpes* (European Red Fox), *Oryctolagus cuniculus* (European Rabbit) and *Felis catus* (Feral Cat).

The potential for the project to contribute to or spread animal pests would be limited because:

- Only small areas of native vegetation would be affected by the project.
- No tracks or cleared corridors would be established that may facilitate the movement of pest species.
- The project would not involve the introduction of other conditions in which animal pest species may thrive and result in an increase in population or spread of these species.

Injury and mortality

During the construction phase of the project injury or mortality may occur as a result of vegetation clearing or direct collision with vehicles and equipment within construction zones. Although some mobile species may be able to exit the area quickly, others may be slower to relocate or may not vacate the area at all, potentially resulting in injury or mortality of the individual.

Appropriate mitigation measures to minimise injury and mortality of fauna species during construction are provided in **Section 7.6.4**.

Wildlife connectivity and habitat fragmentation

Barrier effects may occur as a result of the erection of new and relocated noise walls or other barriers preventing wildlife movement between vegetation fragments. Given that the disturbance footprint generally aligns with existing infrastructure where barriers are already present, it is not expected that the project would significantly exacerbate the existing barrier effect.

Edges created by clearing vegetation for construction works could potentially impact on surrounding vegetation communities. The edge effect may impact on adjacent native vegetation through the increased presence of weeds, particularly around the edges of the disturbance footprint. Edges provide an opportunity for the establishment of weeds which then compete with native species. A particular threatened species likely to susceptible to this mode of impact is *Epacris purpurascens* var. *purpurascens* which has been found along the Hills M2 Motorway corridor. The potential impacts of weed invasion have been discussed above.

Potential for fragmentation of riparian habitat would exist around minor watercourses, including:

- Cockle Creek located adjacent the M1 Pacific Motorway at the top of the catchment of Ku-ring-gai Chase National Park.
- Blue Gum Creek, Darling Mills Creek and Stevenson Creek in Bidjigal Reserve adjacent to the M2 Hills Motorway integration works on the upper tributaries of the Parramatta River catchment.

The Darling Mills Creek compound (C2) is located within the Darling Mills Creek wildlife corridor. This may temporarily impact this riparian corridor.

As the project would only involve minor additions to existing infrastructure within these riparian corridors, it is unlikely that significant impacts on riparian corridors would result from the project. Mitigation measures identified in **Section 7.6.4** would be implemented to further reduce potential impacts on riparian corridors.

Impacts on groundwater dependent ecosystems

Some of the vegetation communities in and around the footprint for the Hills M2 Motorway integration works have a high potential for groundwater dependence. If these communities rely on groundwater, it is likely to be from a shallow aquifer that is perched above the main Hawkesbury Sandstone aquifer. This shallow aquifer is likely to recharge from rainfall and runoff through gullies and from the surrounding local catchment.

The project is unlikely to significantly alter recharge regimes for the local shallow aquifer during construction. Minor changes to local drainage through modification of existing drainage infrastructure and the introduction of new infrastructure would result from the project. However, these changes are not expected to significantly alter current conditions.

Further information on potential groundwater impacts is provided in **Section 7.8** (Hydrogeology and soils).

Increased bushfire occurrence

Two areas of bushfire prone land are present in the vicinity of the project, being around the northern interchange and the areas adjacent to the Hills M2 Motorway integration works. Vegetation within the biodiversity study area exists in a largely urbanised environment and fuels are currently managed by strategically reducing hazards adjacent to assets.

The project would not involve the construction of permanent built or habitable structures within mapped bushfire prone areas. Construction of road and drainage infrastructure within bushfire prone areas would not require hazard reduction.

The Junction Road compound (C11) would be temporarily located on mapped bushfire land during construction of the project. Management of vegetation in and around this site, including provision of appropriate asset protection zones would be considered during detailed design of the compound.

It is possible that activities during construction, such as welding, may provide an ignition source from which a bushfire may be started. This risk would be managed during relevant construction activities and incorporated into emergency management planning, training and escalation protocols on days of increased bushfire risk.

Further details regarding bushfire risks are provided in **Section 8.3** (Hazards and risk).

Noise, vibration and lighting

Indirect impacts on biodiversity could potentially be caused by noise, vibration and lighting during construction of the project. Certain threatened species are particularly susceptible to these potential indirect impacts including:

- Nocturnal birds (such as *Ninox strenua* (Powerful Owl) and *Ninox connivens* (Barking Owl)) may be impacted by daytime construction noise, and temporary lighting during night works, which could affect sleeping patterns. Construction noise and lighting may also discourage the presence prey species.
- Bats (such as *Chalinolobus dwyeri* (Large-eared Pied Bat) and *Miniopterus australis* (Eastern Bent-wing Bat)) and nocturnal mammals could be impacted by increased construction noise during the day and construction lighting at night.
- Diurnal birds may be indirectly impacted by noise. Small woodland birds (such as *Petroica phoenicea* (Flame Robin) and *Petroica boodang* (Scarlet Robin)) are known to be impacted by noise associated with roads.

Noise and vibration impacts during the construction phase of the project are likely to affect fauna species that rely on sound to communicate, or that are nocturnal and sleep during the day when construction activities are at their peak. These species may include bats, diurnal and nocturnal birds, nocturnal mammals and any other fauna species.

The potential impacts of noise, vibration and lighting for individual species have been considered as part of the significance assessments for threatened fauna. In general, the significance assessments concluded that noise, vibration and lighting are unlikely to have a significant impact on birds and mammals in the biodiversity study area because the study area is within an already urbanised area with existing noise, vibration and lighting impacts. Similarly these indirect impacts are unlikely to significantly affect amphibians and reptiles with potential to occur in the biodiversity study area.

Mitigation measures to manage potential noise and vibration, and night lighting impacts are provided in **Section 7.2** (Noise and vibration) **Section 7.5** (Urban design, landscape character and visual amenity) respectively.

Impacts on relevant key threatening processes

The project has the potential to contribute to key threatening processes relevant to threatened species, communities, populations and their habitats as summarised in **Table 7-155**.

Table 7-155 Key threatening processes and potential impacts on biodiversity

Key threatening process	Relevance to the project
Clearing of native vegetation (TSC Act) Land clearance (EPBC Act)	Clearing of vegetation including native vegetation would be undertaken as part of the project as outlined in **Section 7.6.3**. The loss of native vegetation would be offset in accordance with Guideline for Biodiversity Offsets (Roads and Traffic Authority, 2011), as described in **Section 7.6.4.**
Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (TSC Act) Infection of amphibians with chytrid fungus resulting in chytridiomycosis (EPBC Act)	Potential habitat for *Pseudophryne australis* (Red-crowned Toadlet) has been identified within the biodiversity study. While the Red-crowned Toadlet has not been identified through field surveys, there is potential for it to be present in habitat around the project. Movement of vehicles, equipment and people during the construction phase carries a risk of the introduction and spread of the chytrid fungus in these habitats, with potential impacts on threatened frog species. With the implementation of appropriate mitigation measures listed in **Section 7.6.4** the risk of introducing or spreading chytrid fungus would be low.
Infection of native plants by *Phytophthora cinnamomi* (TSC Act)	Movement of vehicles, equipment and people during the construction phase carries a risk of the introduction and spread of the plant pathogen *Phytophthora cinnamomi*. This pathogen is not currently known to occur in the biodiversity study area. With the implementation of appropriate mitigation measures listed in **Section 7.6.4** the risk of introducing and spreading Phytophthora would be low.
Introduction and establishment of Exotic Rust Fungi of the order *Pucciniales* pathogenic on plants of the family *Myrtaceae* (TSC Act)	Movement of vehicles, equipment and people during the construction phase carries a risk of introduction and spread of myrtle rust. Myrtle rust is not currently known to occur in the biodiversity study area but has been recorded nearby as part of the Hills M2 Motorway Upgrade project. With the implementation of appropriate mitigation measures listed in **Section 7.6.4** the risk of introducing and spreading myrtle rust would be low.

Key threatening process	Relevance to the project
Invasion and establishment of exotic vines and scramblers (TSC Act)	Exotic vines and scramblers are present within the biodiversity study area, particularly associated with riparian vegetation or in wetted areas. Movement of vehicles, equipment and people during the construction phase carries a risk of introduction and spread of these exotic vines and scramblers. Disturbance of existing vegetation can also increase the risk of introducing and spreading weed infestations. Appropriate mitigation measures, as described in **Section 7.6.4**, would be implemented to limit the potential introduction and spread of weeds.
Invasion, establishment and spread of *Lantana camara* (TSC Act)	*Lantana camara* (Lantana) has been identified in numerous locations within the biodiversity study area. Movement of vehicles, equipment and people carries a risk of the introduction and spread of Lantana into unaffected areas. Appropriate mitigation measures would be implemented, as described in **Section 7.6.4**, to limit the potential spread of Lantana.
Loss of hollow bearing trees (TSC Act)	The project would result in a worst case permanent removal or lopping of up to 62 hollow bearing trees. The loss of hollow-bearing trees would be offset by installing nest boxes as described in **Section 7.6.4**.

Operation

Permanent changes in hydrology

Changes to hydrology during operation of the project may result from:

- Capture, treatment and discharge of groundwater and deluge water from the main alignment tunnels, on-ramp tunnels and off-ramp tunnels.
- Operational drainage infrastructure for new sections of roadway to maintain the quality of surface water runoff.
- Watercourse crossings.

Discharge of tunnel groundwater and deluge water

Groundwater inflows would occur into tunnel drainage infrastructure during operation. Collected groundwater from the tunnels would be treated at the operational water treatment located within the motorway operations complex near the southern interchange.

The project has been designed to achieve a maximum water discharge quality equivalent to the 95 per cent protection level specified for freshwater eco-systems in accordance with ANZECC guidelines (ANZECC & ARMCANZ, 2000). The discharge water quality level would be determined in consultation with the NSW Environment Protection Authority during the detailed design phase taking into consideration the current water quality of the receiving watercourses.

The treatment capacity of the operational water treatment plant, and the worst case discharge volume to Blue Gum Creek, would be around 0.04 cubic metres per second. Further description of water treatment plant and discharges, including potential geomorphological impacts, is provided in **Section 7.9** (Surface water).

Blue Gum Creek is a first order watercourse with degraded aquatic habitat and degraded riparian areas. Blue Gum Creek flows into Darling Mills Creek, which is a fourth order watercourse with moderate quality aquatic habitat and moderate quality riparian areas.

As Blue Gum Creek is currently ephemeral, the provision of a continuous water supply from the water treatment plant would result in a continual base flow, altering the creek's current flow regime. Discharges from the project would also alter the flow regime of Darling Mills Creek, with potential to increase the frequency, volume and velocity of surface water flows.

No threatened aquatic fauna or flora listed under the TSC Act, *Fisheries Management Act 1994* or EPBC Act have been identified as likely to occur within the biodiversity study area. Assessment of the aquatic ecological values of Blue Gum Creek and Darling Mills Creek (refer to technical working paper: biodiversity, **Appendix J**) indicate that:

- Blue Gum Creek – this watercourse has occasional instream woody debris, low aquatic vegetation richness and rare native aquatic vegetation abundance. Overall the watercourse has been assessed as 'Class 3 – minimal fish habitat'.
- Darling Mills Creek – this watercourse has occasional instream woody debris, absent to low aquatic vegetation richness and absent to rare native aquatic vegetation abundance. Overall the watercourse has been assessed 'Class 3 – minimal fish habitat' (upper reaches) to 'Class 2 – moderate fish habitat'.

The potential impacts arising from the discharge of operational water includes faster flows, bank erosion, pool sedimentation, transport of weeds and increased nutrients. This in turn could lead to a decrease in habitat for macroinvertebrates. Conversely, increased water volume may provide benefits in relation to fish migration and may clean and oxygenate stagnant pools.

Given the degraded nature of Blue Gum Creek and Darling Mills Creek, the limited fish habitat offered in both watercourses, and the unlikely presence of threatened aquatic species, the project is unlikely to have a significant impact on aquatic ecology as a result of operational wastewater discharges. The quality of water discharged from the water treatment plant would be managed to avoid further degradation in the quality of aquatic habitat in both watercourses.

Operational stormwater impacts

An increase in impervious surfaces as part of the project would result in increased runoff during operation. Increased runoff has the potential to alter the flow regimes of local watercourses and to increase the risk of erosion of soils, sedimentation of waterways, bank destabilisation and degradation of water quality. Catchments impacted by surface infrastructure would include:

- Blue Gum Creek catchment– runoff from the southern interchange and Hills M2 Motorway integration works.
- Tedbury Creek catchment – runoff from the Wilson Road tunnel support facility.
- Butterfield Street Creek catchment – runoff from the Trelawney Street tunnel support facility.
- Coups Creek catchment – runoff from the northern interchange.
- Cockle Creek catchment – runoff from the M1 Pacific Motorway tie-in.

Water quality detention basins would be increased in capacity where required to handle additional runoff from surface roads. Four detention basins would be augmented as part of the Hills M2 Motorway integration works and one detention basin would be augmented as part of the M1 Pacific Motorway tie-in works. The alterations to the basins and existing drainage infrastructure would mitigate the potential impacts of increased surface water runoff. Consequently, it is unlikely that increased runoff would have a significant impact on the aquatic ecological environment during operation.

Watercourse crossings

Two existing watercourse crossings would be widened as part of the project: the Darling Mills viaduct and the Yale Close bridge. Widening of existing bridge structures over watercourses has the potential to result in further incremental degradation of riparian vegetation in these areas. Construction works would not encroach into the watercourse, and potential changes to flow patterns and localised scour are therefore not anticipated.

Four culverts would be extended along the Hills M2 Motorway, and one new culvert would be constructed under the M1 Pacific Motorway / Pennant Hills Road connector. The extension of drainage culverts may affect the passage of fish and other aquatic fauna.

The minor extensions of four culverts along the Hills M2 Motorway would be generally consistent with the design and function of existing infrastructure. These minor extensions would not significantly alter the ability of culverts to be accessed and traversed by native fauna. The new culvert to be constructed under the M1 Pacific Motorway / Pennant Hills Road connector is intended to provide drainage relief for a probable maximum flood event and is not intended to provide or replace existing passage for aquatic and other fauna.

Injury and mortality

Given that the project would result in widened carriageways on the Hills M2 Motorway and the M1 Pacific Motorway, the likelihood of vehicle strike is increased during operation as fauna would need to travel further to cross these motorways.

Although the project may potentially result in some injury or mortality of fauna species, the project is unlikely to cause a significant increase in fauna incidents during operation relative to the existing situation. The presence of noise walls and deep cuttings along significant areas of the motorways would also act to limit the number and quality of potential fauna crossings.

Appropriate mitigation measures to minimise injury or mortality of fauna species during operation are provided in **Section 7.6.4**.

Noise, vibration and lighting

Changes to the noise, vibration and lighting environment have the potential for indirect impacts on flora and fauna, including threatened fauna species, during operation of the project.

The threatened species most at risk from indirect changes to noise, vibration and light impacts are:

- Nocturnal birds such as the Powerful Owl and the Barking Owl.
- Bats such as the Long-eared Pied Bat and the Eastern Bent-wing Bat.
- Diurnal birds such as the Flame Robin and the Pink Robin.

Operational noise, which would be continuous, is unlikely to significantly impact on threatened fauna species given that the majority of the project would be located underground. Potential increased traffic due to the surface road widening is unlikely to significantly alter the local acoustic environment, which is already substantially characterised by road traffic noise.

Changes to the availability of light as a result of the project may potentially impact both flora and fauna species. Potential impacts may include:

- Altering light regimes affecting plant growth.
- Overshadowing of flora species by noise walls and other structures.
- Changes to micro-climates caused by overshadowing or increased light potentially increasing the likelihood of weed invasion.
- Impacts to typical nocturnal fauna behaviour through increase of light at night.

The potential impacts associated with noise, vibration and lighting have been considered as part of the significance assessments for threatened species. The significance assessments have been conducted on the basis that lighting is to be fitted across the whole operational footprint. In general the significance assessments concluded that noise, vibration and lighting are unlikely to have a significant impact on birds and mammals in the biodiversity study area. Similarly these indirect impacts are unlikely to significantly affect amphibians and reptiles with potential to occur in the biodiversity study area.

7.6.4 Environmental management measures

Potential biodiversity impacts have been considered throughout the development of the project. The initial route selection process identified a preferred route options which minimised potential biodiversity impacts. Further, the preferred tender design avoided impacts to the high value ecological area located at Brickpit Park and Kenley Park. There would, however, still be some biodiversity impacts, including impacts to endangered ecological communities and threatened species. Biodiversity offset measures are proposed in relation to these impacts and are described below.

Environmental management measures relating to biodiversity during construction and operation are provided in **Table 7-156**. Mitigation and management measures relevant to biodiversity are also included in other sections of this environmental impact statement as follows:

- Erosion and sediment control measures in **Section 7.9** (Surface water).
- Noise mitigation in **Section 7.2** (Noise and vibration).
- Lighting mitigation in **Section 7.5** (Urban design, landscape character and visual amenity).

Table 7-156 Environmental management measures – biodiversity

Impact	No.	Environmental management measure	Timing
Construction			
General	B1	A Flora and Fauna Management Plan would be developed for the construction phase of the project to identify potential impacts and mitigation measures.	Pre-construction
Clearing of native vegetation	B2	The disturbance and clearance of established vegetation would be minimised as far as feasible and reasonable.	Pre-construction and construction
	B3	Areas of vegetation to be retained would be protected from accidental damage.	Construction
	B4	Pre-clearing surveys would be undertaken by a suitably qualified ecologist to identify to presence of: • Hollow-bearing trees and other habitat features. • Threatened flora and fauna.	Construction
	B5	Where feasible and reasonable, topsoil and habitat elements (such as woody debris and bushrock) would be stored and reused onsite or in adjacent bushland. Cuttings or seed material may also be gathered from the construction footprint for landscaping plant stock.	Construction
Adverse impacts to riparian zones and aquatic habitats	B6	Temporary watercourse crossings would be designed in accordance with relevant guidelines including Fish and Fauna Friendly Waterway Crossing (Fairfull and Witheridge, 2003).	Construction
	B7	Viaduct and bridge structural elements would be located out of the waterway where feasible and reasonable.	Construction

Impact	No.	Environmental management measure	Timing
	B8	Creeks, riparian zones or vegetated buffers disturbed by the project would be revegetated with the restoration to pre-disturbance conditions.	Construction
Spread of weeds and pathogens	B9	Weeds within the construction footprint would be actively managed prior to vegetation clearing. Cleared weed material would be disposed of to a facility licensed to receive green waste.	Construction
	B10	Machinery would be is cleaned prior to entering the project construction sites.	Construction
	B11	The identification of pathogens would be undertaken as part of pre-clearing inspections. In the event that pathogens are identified within the construction footprint, appropriate mitigation measures would be identified and implemented.	Construction
Loss of Epacris purpurascens	B12	Relocation of *Epacris purpurascens* species where identified within disturbance footprints, ideally to areas identified as a biodiversity offset and / or where future disturbance is unlikely.	Construction
Loss of hollow bearing trees	B13	The loss of hollow bearing trees would be mitigated by: • Relocation / replacement of existing nest boxes impacted by construction. • Nest boxes would be provided as replacement for hollow bearing trees impacted by construction.	Construction
Impact on culverts or buildings with potential threatened bat habitat	B14	A microbat management plan would be developed and implemented including: • Conduct monitoring of existing culverts and buildings commencing at least six months prior to construction / demolition commencing at each relevant culvert or building. • Maintaining appropriate exclusion zones and managing night works through the breeding and lactation period in the vicinity of identified microbat habitat. • Filling pipe joins in culverts identified as not being microbat habitat prior to passive exclusion (eg installation of one-way flaps at potential grab hole locations) to ensure alternative roosting locations are not created in culverts. • Minimising light spill and noise impacts into surrounding native vegetation.	Construction
Impacts on fauna due to draining of stormwater basins	B15	Surveys of stormwater basins would be undertaken by a suitably qualified ecologist prior to draining works to identify the potential presence of fauna. Appropriate fauna handling and release protocols would be established to remove fauna from water bodies prior to draining works.	Construction

Impact	No.	Environmental management measure	Timing
Operation			
General	OpB1	A management plan would be developed and implemented to identify and mitigate potential ongoing impacts including procedures for: • Management of weeds. • Management of riparian areas associated with the discharge of treated water. • Maintenance of nest boxes.	Operation

Biodiversity offsets

Although mitigation and management measures would be implemented for the project, impacts to native vegetation, including endangered ecological communities and threatened flora are likely to occur which require offsetting.

The required offsets have been calculated using the Biobanking Assessment Methodology. Offset calculations have been based on the preferred tender design disturbance footprint and a worst case biodiversity assessment which assumes clearance of all vegetation within the construction footprint. This may be revised during detailed design if biodiversity impacts change. The full details of the offset methodology and calculation are provided in the technical working paper: biodiversity (**Appendix J)**. This calculation identified that 280 ecosystem credits would be required for the clearance associated with the project (as summarised in **Table 7-157**). For example, this would result in around 30 hectares of offset land required when calculated using an average of 9.3 credits generated per hectare of Biobanking site. The actual hectares of offset land required would be determined based on the detailed design and the nature of the offset site.

Table 7-157 Summary of offset credits

Biometric vegetation type	Mapped vegetation community	Area impacts (ha)	Number of credits required
Sydney blue Gum – Blackbutt – Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin	Blue Gum High Forest	2.81	163
Sydney Peppermint – Smooth-barked Apple – Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin	Coastal Enriched Sandstone Moist Forest Coastal Sandstone Gallery Rainforest Coastal Enriched Sandstone Dry Forest	0.20	8
Red Bloodwood – Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin	Coastal Shale-Sandstone Forest Regeneration – Native	1.90	90
Smooth-barked Apple – Red Bloodwood – Sydney Peppermint heathy open forest in sandstone gullies of western Sydney, Sydney Basin	Hinterland Sandstone Gully Forest	0.72	19
Total		5.63	280

The Sydney Turpentine-Ironbark Forest vegetation community at the Wilson Road compound (C6), and the areas mapped as Blue Gum individuals have not been included in the offset calculation at this time. Access to the Wilson Road compound (C6) site was restricted during surveying and the vegetation community on the site would require confirmation as to whether it is present prior to calculation of the offset.

Offset calculation outcomes for threatened species which would require species credits include:

- 1,767 *Epacris purpurascens* var. *purpurascens* credits noting however that it is believed that these plants originated from translocation and seed soil bank propagation from the Hills M2 Motorway Upgrade project (which has proven successful), and a similar approach would be carried out for this project.
- 67 credits for the Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai local government areas.
- Four microchiropteran bat species that may occur within the biodiversity study area (Large-eared Pied Bat, Little Bent-wing Bat, Eastern Bent-wing Bat, Southern Myotis) which have species credit components. None of these species are expected to be impacted by the project. Furthermore, it is considered that impacts on culverts with potential roosting habitat, hollow bearing trees or nest boxes would be mitigated by the relocation of nest boxes and provision of additional nest boxes (see **Section 7.6.4**) such that offsets specific to these species would not be required.

This Biobanking assessment would be reviewed and refined in consultation with the Office of Environment and Heritage and Department Planning and Environment as part of the Biodiversity Offset Strategy. The Biodiversity Offset Strategy would be submitted to and approved by Department Planning and Environment.

All reasonable and feasible attempts would be made to secure an appropriate offset site(s). However, in the event that appropriate offsite sites for the total offset credits cannot be obtained, the offset strategy would include a range of supplementary measures such as:

- Actions outlined in threatened species recovery programs.
- Actions that contribute to threat abatement programs.
- Biodiversity research and survey programs.
- Rehabilitating degraded aquatic habitat.