

9.5 Ecology

An assessment of the impacts on flora and fauna associated with the M2 Upgrade project has been undertaken and is presented below. This assessment is supported by *Technical Paper 3 – Flora and Fauna* (Volume 2).

Director-General's Requirements	Where addressed
<i>Impacts on ecology:</i>	
<ul style="list-style-type: none"> The environmental assessment must include an assessment of the potential ecological impacts of the project, with specific reference to the need for vegetation clearing, habitat and connectivity implications, edge effects, and stormwater and watercourse implications. 	Section 9.5.2, Technical Paper 3
<ul style="list-style-type: none"> The environmental assessment must make specific reference to impacts on threatened species, populations and communities, including the Sydney Turpentine-Ironbark Forest and Blue Gum High Forest Endangered Ecological Communities, and the native fauna that may utilise those communities. 	Sections 9.5.1, 9.5.2, Technical Paper 3
<ul style="list-style-type: none"> The environmental assessment shall demonstrate that the extent of vegetation clearing has been minimised through the design of the project, and shall include details of any off-set measures that may be proposed. 	Section 9.5.3, Technical Paper 3

9.5.1 Methodology

The objectives of the ecological assessment are to:

- Produce an impact assessment of proposed works with respect to terrestrial and aquatic ecology based on existing information and additional field surveys.
- To assess potential impacts on flora and fauna in the area and determine the most appropriate mitigation measures to address flora and fauna impacts.
- Give particular attention to the impact on critical habitat, threatened species, populations and ecological communities, or their habitat (as defined under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Threatened Species Conservation Act 1995* (TSC Act), the Threatened Species Conservation provisions of the *Fisheries Management Act 1994* and the *Fisheries Management Amendment Act 1997* (FM Act).
- To follow the heads of consideration as outlined in the *Draft Guidelines for Threatened Species Assessment* by the Department of Environment and Conservation (now DECCW) and the Department of Primary Industries (now Department of Industry and Investment), 2005 (DEC and DPI, 2005) and the *Significant Impact Guidelines and Matters of National Significance* outlined by the Department of Environment and Heritage (now DEWHA) (DEH, 2006).
- To address the DGRs for the project.

Assessments of significance were conducted for threatened species listed under the TSC Act and followed the heads of consideration outlined in the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). For threatened species listed under the EPBC Act, assessments of significance were undertaken in accordance with the *Significant Impact Guidelines and Matters of National Significance* (DEH, 2006).

The results of field surveys, a review of previous studies, a review of published information sources including the Commonwealth Government Species Profile and Threats (SPRAT) database, the NSW

Government Atlas of NSW Wildlife and previous vegetation mapping undertaken in the locality were used to prepare the information presented in this report.

Several databases were searched to provide information on significant flora and fauna species that have been found in the study area, including:

- The EPBC Act Protected Matters Search Tool (DEWHA) online database for Matters of National Environmental Significance).
- The National Parks and Wildlife Service (NPWS) Atlas of NSW Wildlife.

Previous assessments for the study area were reviewed. Information on fauna habitat contained in the Rapid Fauna Habitat Assessment of the Sydney Metropolitan Catchment Management Authority Area (DECC 2008) has been incorporated where relevant. Field surveys were also undertaken through a variety of methods, including investigations for targeted flora and fauna. The survey effort is outlined below.

Flora

Flora surveys were conducted over six days between 26 November 2008 and 24 March 2009 by two AECOM ecologists. The purpose of the surveys was to assess the likely impact of the proposed action on the vegetation communities and significant flora species present or likely to occur within the study area.

Survey sites were selected based on a preliminary investigation of the study area using aerial photography, topographic maps, vegetation mapping undertaken by Tozer *et al.* (2006) and the existing threatened species database searches (refer to section 2.1 of Technical Paper 3). Flora surveys involved the recording of the structure, condition and composition of vegetation communities present and a targeted search for threatened flora species throughout the study area, targeting areas of greatest potential for the species to occur. The distribution of vegetation communities as per existing mapping (Tozer *et al.* 2006) was ground-truthed.

Plant species were identified within eight 20 metre x 20 metre survey plots and a random meander search for threatened flora species (refer to section 4.4.2 of Technical paper 3 for a list of targeted species) was conducted in the vicinity of each plot. Random meander transects targeting threatened flora species were also undertaken throughout the entire length of bushland potentially impacted.

Fauna

Fauna surveys were conducted between November 2008 and March 2009 by two AECOM ecologists. The field survey methods used to detect and assess habitat for fauna species are listed in Table 1 of Technical Paper 3. The survey effort complies with the survey effort recommended by the *Draft Guidelines for Threatened Species Assessment* under Part 3A (DEC and DPI, 2005) for the study area size, habitat types available on the site and seasonal factors.

Fauna surveys including trapping were conducted during the preparation of the environmental impact assessment reports for the existing M2 Motorway and were not repeated in this study. Field survey methods for the project were chosen such that adequate information would be available to fully assess the potential impacts of the upgrade on fauna species of conservation significance. Based upon the availability of existing information, fauna survey methods such as cage-trapping of mammals, pitfall trapping and detailed aquatic surveys were not undertaken.

In addition to fauna surveys, the following habitat assessments were undertaken:

- Observation of the location, extent and density of key habitat features such as mature, potentially hollow bearing trees, waterways, seepages, rocky outcrops, vegetation types and soils.
- Assessment of the condition of aquatic habitats through noting factors such as turbidity, rubbish, exotic fish species, surface films, submerged and emergent vegetation and substrates.
- Assessment of the condition of vegetation as habitat for fauna species through observation of factors including weed infestation, structural layering, species composition, nectar and fruit resources and maturity and condition of trees.

Survey limitations

The environmental field surveys and assessments conducted are based on environmental conditions at the time of survey and therefore the absence of threatened species recorded is not indicative of the lack of threatened species inhabiting the study area. It is noted that species such as *Pimelea curviflora* var. *curviflora*, *Tetradlea glandulosa*, and *Hibbertia superans* are in flower in November, which is when survey was carried out. For those threatened flora species that are difficult to detect outside of their flowering time a precautionary approach was taken and species were assumed to be present if suitable habitat was observed. Therefore, assessments of significance are based on the appropriateness of habitat on the site for threatened flora and fauna species and the presence of key habitat features as listed in the relevant DECCW species profiles.

9.5.2 Existing environment

Landscape context

Much of the area surrounding the M2 corridor is highly urbanised and consists primarily of residential properties, parkland, weed-infested areas and riparian vegetation. Several larger areas of remnant native vegetation exist within and adjacent to the areas proposed to be directly, or indirectly, affected by the proposed upgrade works.

Several larger areas of remnant native vegetation exist within and adjacent to the study area. The most significant of these include:

- Bidjigal Reserve (formerly Excelsior Reserve and Darling Mills State Forest).
- Vegetation in the vicinity of Devlins Creek including Beecroft Reserve, Beecroft Reserve South, Chilworth Reserve and Cheltenham Park.
- Vegetation surrounding Terrys Creek between Lucknow Park, Berriwerri Reserve and Somerset Park.
- Parts of Lane Cove National Park adjacent to the M2 corridor in Macquarie Park.

These areas have greater potential as habitat for a wider variety of fauna species due to their larger size, greater habitat diversity, more natural vegetation condition and connectivity to other areas of wildlife habitat. These areas have more potential to support viable populations of flora and fauna species as they are larger and better connected. These features make these areas more resistant to local extinction of flora and fauna species due to events such as fires and disease outbreaks and processes such as changing vegetation characteristics and predation by feral animals.

As a result of the size, connectivity and complexity of these areas, populations eliminated from part of their range may become re-established from refugia that were unaffected. The conservation and management of these areas and the corridors that connect them is important to the conservation of biodiversity in the locality.

As much of the area surrounding the study area is highly urbanised, fauna habitat within these areas is largely limited to streams and streamside vegetation and the canopies of remnant and planted trees. Only native and exotic fauna species that are able to utilise highly modified habitat are likely to exist in this area.

Due to their mobility and ability to cope with habitat fragmentation, highly mobile native fauna species typical of open environments such as birds and bats would be able to exploit feeding, nesting and roosting opportunities that exist within these habitats. Highly adaptable native mammal species which are capable of utilising a wide variety of habitats such as the Brush-tailed Possum (*Trichosurus vulpecula*) and Common Ring-tailed Possum (*Pseudocheirus peregrinus*) persist here. Several bat species, such as the White-striped Mastiff Bat (*Tadarida australis*), Chocolate Wattle Bat (*Chanlinolobus morio*) and the threatened Grey-headed Flying Fox (*Pteropus poliocephalus*), are also found in these environments.

A larger diversity of native bird species inhabits urban areas such as the Noisy Miner (*Manorina melanophrys*), Pied Currawong (*Strepera graculina*), Laughing Kookaburra (*Dacelo novaeguineae*), Sulphur-crested Cockatoo (*Cacatua galerita*), Rainbow Lorikeet (*Trichoglossus haematodus*), Red Wattlebird (*Anthochaera carunculata*), Australian Magpie (*Gymnorhina tibicen*) and Tawny Frogmouth (*Podargus strigoides*). The threatened Powerful Owl (*Ninox strenua*) is also sometimes seen in urban areas in the vicinity of bushland.

Exotic mammal species such as the European Rabbit (*Oryctolagus cuniculus*), Black Rat (*Rattus rattus*), House Mouse (*Mus musculus*), European Red Fox (*Vulpes vulpes*) and feral Domestic Cat (*Felis catus*) are found in the study area, along with exotic bird species such as Common Myna (*Acridotheres tristis*), Spotted Turtle-dove (*Streptopelia chinensis*), Starling (*Turdus merula*) and Red-whiskered Bulbul (*Pycnonotus jocosus*).

As a result of habitat loss and competition, and predation by exotic and over-abundant native species, fauna species that require a diverse understorey, disturbance-sensitive species, species which are susceptible to predation by pets and feral animals, and species with very specific habitat requirements are unlikely to exist in urban environments.

The waterways in the vicinity of the study area are degraded as a result of a number of factors including increased erosion due to the concentration of stormwater flows, weed invasion, polluted catchment runoff and the presence of exotic fish species (such as *Gambusia holbrooki*). As a result, frogs, fish and aquatic invertebrates that are sensitive to disturbance are unlikely to persist in the waterways.

Nonetheless, a variety of disturbance tolerant frog species (for example, Striped Marsh Frog (*Limnodynastes peronii*), Common Eastern Froglet (*Crinia signifera*), Eastern Dwarf Tree-frog (*Litoria fallax*), Green Stream Frog (*Litoria phyllochroa*) and Peron's Tree Frog (*Litoria peronii*)) are likely to use these habitats. A number of native fish species are also likely to persist.

Vegetated wildlife corridors within the urban environment are mainly confined to these waterways which connect the bushland remnants that are largely located in the steep sandstone valleys.

Vegetation communities in the M2 Motorway study area

The following seven native vegetation communities are mapped as occurring in the areas adjacent to the M2 Motorway:

- Coastal Sandstone Ridgetop Woodland.
- Coastal Sandstone Gully Forest.
- Hinterland Sandstone Gully Forest.
- Sydney Hinterland Transition Woodland.

- Sandstone Riparian Scrub.
- Blue Gum High Forest.
- Sydney Turpentine-Ironbark Forest.

The distribution of these vegetation communities, as well as the other vegetation communities occurring in the region (as described in the predictive vegetation mapping datasets) is shown in Figure 29.

Appendix B in Technical Paper 3 shows detailed vegetation mapping for the entire M2 Upgrade project route in seven maps. The vegetation maps in Appendix B are derived from the existing vegetation mapping for the area (Figure 29) and field survey.

Threatened vegetation communities

Of the vegetation communities mapped as occurring in the study area, Sydney-Turpentine Ironbark Forest and Blue Gum High Forest are threatened ecological communities under the TSC Act and EPBC Act. Field surveys found no Sydney-Turpentine Ironbark Forest present within the M2 corridor. Approximately 1.36 hectares of Blue Gum High Forest in moderate to poor condition was identified in the study area as detailed below.

Blue Gum High Forest

This community is listed as a critically endangered ecological community (CEEC) under the TSC Act as Blue Gum High Forest and under the EPBC Act as Blue Gum High Forest of the Sydney Basin Bioregion.

This is a moist tall open forest community in which Sydney Blue Gum (*Eucalyptus saligna*) is a dominant species together with a combination of other species including Smooth-barked Apple (*Angophora costata*), Grey Ironbark (*Eucalyptus paniculata*), Blackbutt (*Eucalyptus pilularis*) and Turpentine (*Syncarpia glomulifera*). This vegetation is referred to as Blue Gum High Forest (unit p153) in Tozer *et al.* (2006).

Trees within this vegetation community can form large hollows. Threatened fauna species known to occur in remnant Blue Gum High Forest include Sugar Glider (*Petaurus breviceps*), Powerful owl (*Ninox strenua*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Glossy Black Cockatoo (*Calyptorhynchus lathamii*), Swamp Wallaby (*Wallabia bicolor*) and Brush-turkey (*Alectura lathamii*) (DECC 2008). Potential impacts upon threatened species with a moderate to high likelihood of occurrence within the study area are discussed in Section 9.5.3.

This vegetation type is restricted to ridgetop plateaus and upper slopes on clay soils derived from Wianamatta shales. Prior to previous clearing for urban development and road construction, a number of areas along the M2 corridor may have contained this vegetation community or the closely allied Sydney Turpentine-Ironbark Forest. The extent and condition of this community has been verified through on ground inspection and the present distribution within the study area is restricted to a narrow band between the M2 Motorway and Pennant Hills Golf Course to the north. This area is approximately 1.36 hectares in area and in moderate to poor condition.

The species composition of this patch shows affinities with Turpentine-Ironbark Forest. The dominance of Sydney Blue Gum and Grey Ironbark, the lack of Turpentine and the composition of the understorey and ground layers suggest that this vegetation patch is more closely aligned with the definition of Blue Gum High Forest. A gradation into vegetation more similar to Turpentine-Ironbark Forest occurs at the western extent of the patch as indicated by a drier understorey and an increasing dominance by Rough-barked Apple (*Angophora floribunda*).

The characteristic species of this Blue Gum High Forest community are described in Table 79.

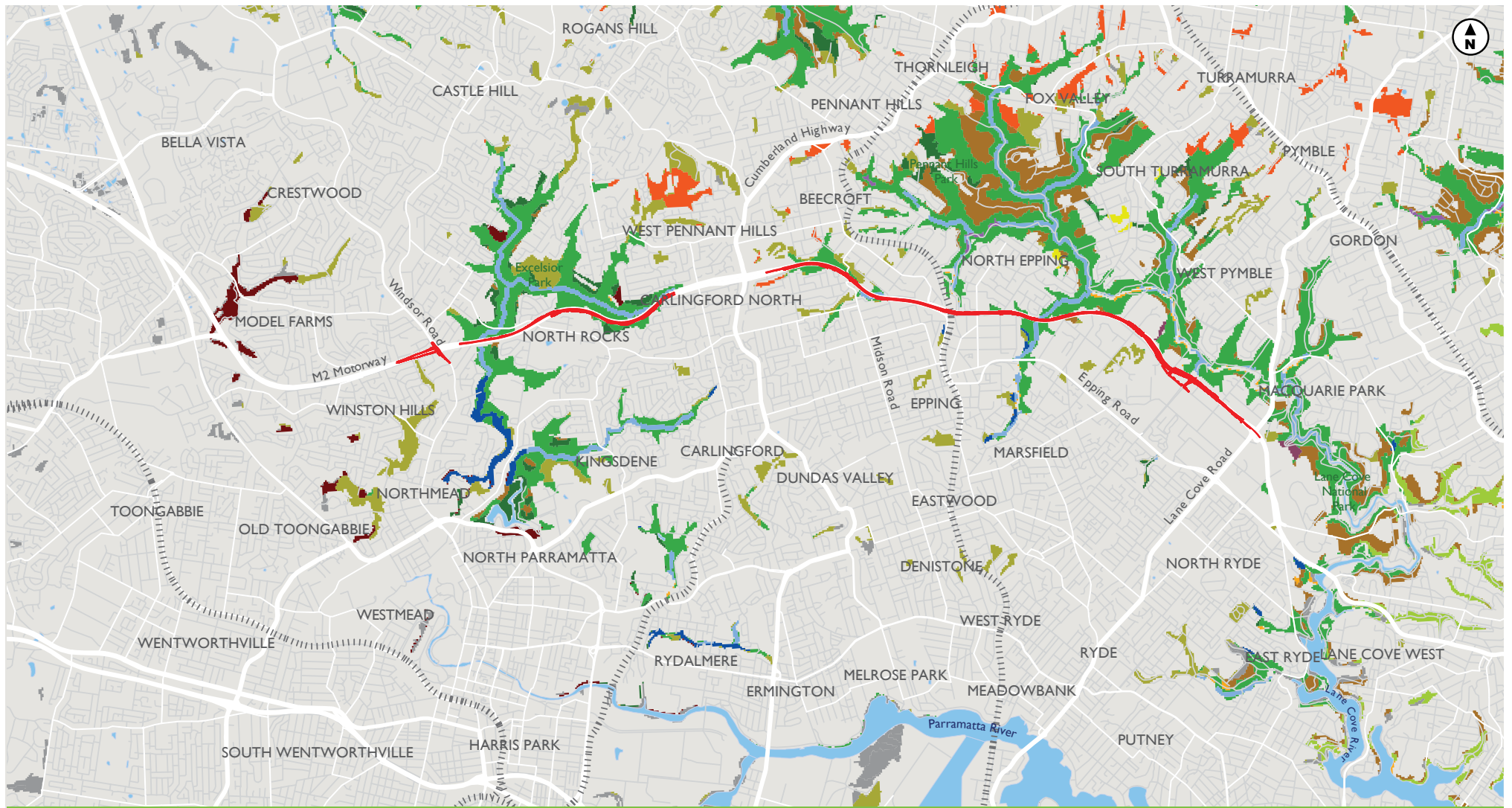
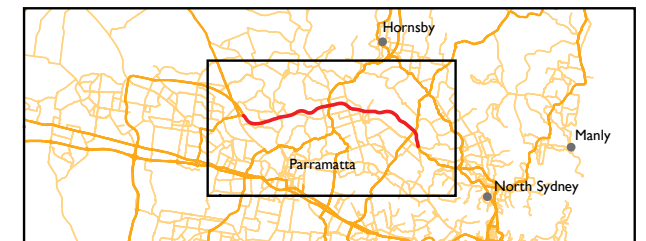


Figure 29 – Vegetation of the Study Area

Vegetation type

- | | | |
|--|---------------------------------------|-----------------|
| Blue Gum High Forest | Lower Blue Mountains Wet Forest | Extent of works |
| Coastal Sandstone Plateau Heath | Sandstone Riparian Scrub | |
| Coastal Sandstone Gully Forest | Sydney Hinterland Transition Woodland | |
| Coastal Sandstone Ridgetop Woodland | Sydney Shale - Ironstone Cap Forest | |
| Coastal Warm Temperate Rainforest | Sydney Swamp Forest | |
| Cumberland Shale Sandstone Transition Forest | Sydney Turpentine Ironbark Forest | |
| Hinterland Sandstone Gully Forest | Other vegetation | |



Source: RTA, 2009, Tozer et. al, 2006. The vegetation extents shown in these maps are from predictive vegetation mapping datasets and may not represent the vegetation actually present at these locations

Table 79 Blue Gum High Forest canopy species

Native canopy species	
Common name	Botanical name
+Smooth-barked Apple	Angophora costata
+Grey Ironbark	Eucalyptus paniculata
+Blackbutt	Eucalyptus pilularis
+Sydney Blue Gum	Eucalyptus saligna
+Turpentine	Syncarpia glomulifera
#Grey Gum	Eucalyptus punctata
#Red Mahogany	Eucalyptus resinifera
+ = dominant canopy species, # = less frequent species	

Sydney Turpentine-Ironbark Forest

Sydney Turpentine-Ironbark Forest is listed as a CEEC (Turpentine–Ironbark Forest of the Sydney Basin Bioregion) under the EPBC Act and the TSC Act.

EPBC Act Definition

Sydney Turpentine-Ironbark Forest is an open-forest of mixed and varying canopy species composition in which Turpentine (*Syncarpia glomulifera*) and ironbarks (*Eucalyptus spp.*) are dominant. Other tree species include Red Bloodwood (*Corymbia gummifera*), Sydney Blue Gum (*E. saligna*), Grey Gum (*E. punctata*), Narrow-leaved Ironbark (*E. crebra*), Mountain Grey Gum (*E. cypellocarpa*), Round-leaved Gum (*E. deanei*) and Red Ironbark (*E. fibrosa*) (DEWHA 2009).

Low tree and shrub species include *Acacia parramattensis*, *Breynia oblongifolia*, *Dodonaea triquetra*, *Leucopogon juniperinus*, *Notelaea longifolia*, *Ozothamnus diosmifolius*, *Pittosporum revolutum*, *P. undulatum*, *Polyscias sambucifolia* and *Maytenus silvestris*. Ground layer species include *Adiantum aethiopicum*, *Austrostipa pubescens*, *Dianella caerulea*, *Dichondra repens*, *Entolasia stricta*, *Lomandra longifolia*, *Poa affinis*, *Pseuderanthemum variabile* and *Themeda australis*. Climbers include *Eustrephus latifolius*, *Glycine clandestina* and *Pandorea pandorana* (DEWHA 2009).

The Commonwealth listing for the CEEC includes vegetation in the following condition:

- The vegetation contains some characteristic components from all structural layers (tree canopy, small tree/shrub midstorey, and understorey).
- Tree canopy cover is greater than 10% and remnant size is greater than one hectare. These areas have the greatest conservation value and their high quality and size makes them most resilient to disturbance.
- Remnants with tree canopy cover less than 10% are also included in the ecological community, if the fragments are greater than one hectare in size and occur in areas of native vegetation in excess of five hectares in area. These areas enhance the potential for connectivity and viability of the ecological community. They support native flora and fauna species by facilitating gene flow among remnants and buffering against disturbance (DEH 2005).

Areas mapped as Sydney-Turpentine Ironbark Forest within the M2 corridor were inspected and found to be:

- Less than one hectare in area, highly disturbed and lacking an intact ground layer or understorey; and/or
- Consistent with the floristic composition of the larger patches of the adjacent Hinterland Sandstone Gully Forest vegetation community.

TSC Act Definition

Under the NSW TSC Act definition, Sydney Turpentine-Ironbark Forest is an open forest community and the dominant canopy trees are Turpentine (*Syncarpia glomulifera*) and Grey Ironbark (*Eucalyptus paniculata*). Common understorey shrubs include Sweet Pittosporum (*Pittosporum undulatum*), Hop Bush (*Dodonaea triquetra*), Elderberry Panax (*Polyscias sambucifolia*) and Sickle Wattle (*Acacia falcata*).

Sydney Turpentine-Ironbark Forest occurs on fertile soils in an area of moderate rainfall. It is transitional between Cumberland Plain Woodland in drier areas and Blue Gum High Forest on adjacent higher rainfall ridges. As a transitional community, the species composition varies according to the influence of sandstone and aspect.

The areas of vegetation within and adjacent to the M2 corridor that have been mapped as Sydney Turpentine-Ironbark Forest under the alternative vegetation classifications described below have been inspected and were subject to detailed flora surveys. The dominant canopy species in these areas are Blackbutt (*Eucalyptus pilularis*) and Turpentine (*Syncarpia glomulifera*) with only occasional specimens of other tree species including Smooth-barked Apple (*Angophora costata*) and Red Bloodwood (*Corymbia gummifera*) present. No ironbark species were detected within these areas.

The moderately dense understorey in these areas consists of a range of species that are found in a variety of soil types and vegetation communities. The sparse to moderately dense ground layer vegetation is a mixture of low shrubs, herbs, grasses and sedges.

Vegetation Mapping Schemes

In the mapping of Tozer *et al* (2006) as shown in Figure 29, small isolated occurrences of this community are mapped in the Beecroft and Carlingford North areas.

Other vegetation mapping schemes have labelled vegetation as Sydney Turpentine-Ironbark Forest inconsistently across the locality of the M2 corridor. The Native Vegetation of the Cumberland Plain maps (NPWS 2002) show extensive areas (including developed areas such as roads, residences) as this community, however these maps have limitations in their applicability to fine scale assessment of vegetation due to a number of factors described in the associated interpretation guidelines (NPWS 2002).

A recently released draft vegetation community mapping scheme for the Sydney metropolitan catchment area (DECCW 2009 a) shows some areas as Sydney Turpentine-Ironbark Forest which are mapped as Hinterland Sandstone Gully Forest by Tozer *et al* (2006) and as Blackbutt Gully Forest by Smith and Smith (2008). The mapping scheme is currently a draft open to comment and subject to change.

Neither the TSC Act nor the EPBC Act Threatened Species Scientific Committee's advice regarding this community includes Blackbutt (*Eucalyptus pilularis*) as a dominant or frequently occurring species. While the understorey and ground layer vegetation observed shows a resemblance to that of Sydney

Turpentine-Ironbark Forest, its composition and structure are more closely aligned with the Hinterland Sandstone Gully Forest community.

In light of these factors, this vegetation within the study area is considered to be Hinterland Sandstone Gully Forest with a slightly higher than typical clay soil influence and not Sydney Turpentine-Ironbark Forest.

The results from flora surveys conducted within areas mapped as Sydney Turpentine-Ironbark Forest adjacent to the M2 Motorway is presented in Appendix D and summarised below in Table 80.

Table 80 Flora survey data within the M2 corridor

Native Canopy and Shrub Species		Location of flora quadrat		
Common Name	Botanical Name	5- (Bidjigal Reserve)	11- (Devlins Creek Cheltenham)	12- (Devlins Creek North Epping)
Narrow-leaved Apple	<i>Angophora bakeri</i>	X		
Smooth-barked Apple	<i>Angophora costata</i>	X	X	X
Forest Oak	<i>Allocasuarina torulosa</i>	X		
Old Man Banksia	<i>Banksia serrata</i>	X		
Blackbutt	<i>Eucalyptus pilularis</i>	X	X	X
*Lantana	<i>Lantana camara</i>	X	X	X
Paperbark Tea-tree	<i>Leptospermum trinervium</i>	X		
*Broad-leaf Privet	<i>Ligustrum lucidum</i>		X	
*Small-leaf Privet	<i>Ligustrum sinense</i>	X	X	X
Sweet Pittosporum	<i>Pittosporum undulatum</i>	X		
Turpentine	<i>Syncarpia glomulifera</i>	X		
*=exotic species				

Terrestrial plant species of conservation significance

Searches of the NPWS Atlas of NSW Wildlife and EPBC Act Protected Matters Search Tool were conducted to determine whether threatened plant species listed under the TSC Act or EPBC Act are likely to occur in the vicinity of the project. The database search revealed that there are a number threatened species recorded in the vicinity of the site (Figure 30).

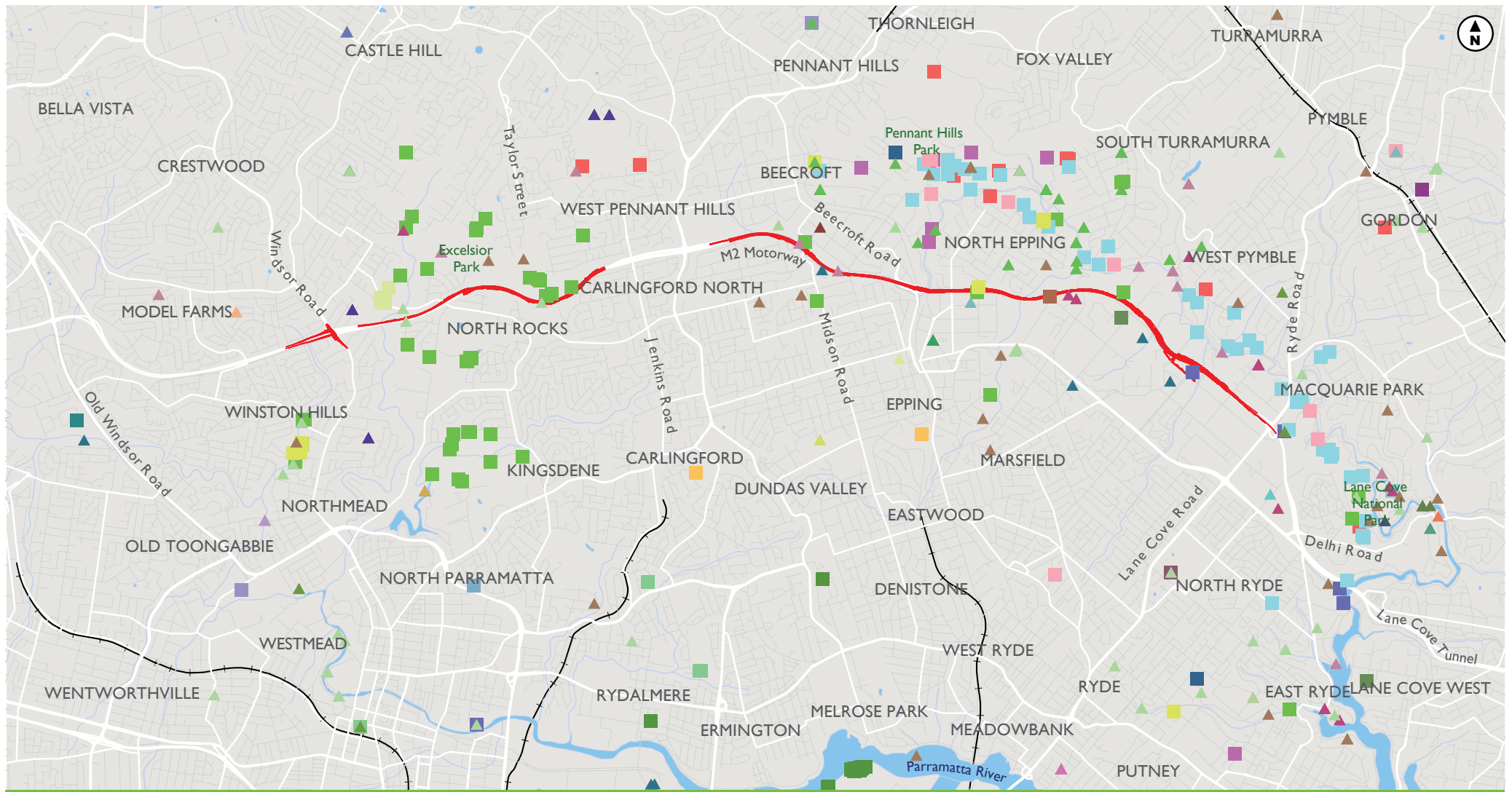
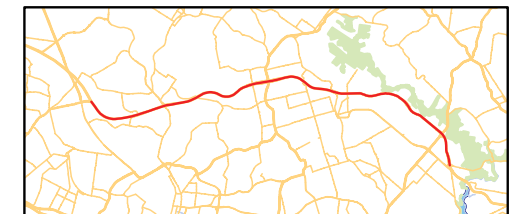


Figure 30 – Threatened flora and fauna species in the study area

- | | | | | | | |
|-------------------------|------------------------------|--------------------------|-------------------------|--|--------------------------------------|--------------------------|
| — Extent of Works | ▲ Cotton Pygmy-Goose | ▲ Grey-headed Flying-fox | ▲ Southern Myotis | Threatened FLORA | ■ Grammitis stenophylla | ■ Pimelea spicata |
| Threatened Fauna | ▲ Eastern Bentwing-bat | ▲ Little Lorikeet | ▲ Spotted-tailed Quoll | ■ Acacia pubescens | ■ Haloragodendron lucasii | ■ Pomaderris prunifolia |
| ▲ Australasian Bittern | ▲ Eastern Freetail-bat | ▲ Osprey | ▲ Superb Fruit-Dove | ■ Callistemon linearifolius | ■ Hibbertia superans | ■ Prostanthera marifolia |
| ▲ Barking Owl | ▲ Gang-gang Cockatoo | ▲ Pink Robin | ▲ Superb Parrot | ■ Darwinia biflora | ■ Leptospermum deanei | ■ Syzygium paniculatum |
| ▲ Black Bittern | ▲ Glossy Black-Cockatoo | ▲ Powerful Owl | ▲ Swift Parrot | ■ Darwinia peduncularis | ■ Melaleuca deanei | ■ Tetratheca glandulosa |
| ▲ Black-necked Stork | ▲ Greater Broad-nosed Bat | ▲ Red-crowned Toadlet | ▲ Yellow-bellied Glider | ■ Epacris purpurascens var. purpurascens | ■ Persoonia hirsuta | ■ Triplarina imbricata |
| ▲ Black-tailed Godwit | ▲ Green and Golden Bell Frog | ▲ Regent Honeyeater | | ■ Eucalyptus nicholii | ■ Persoonia nutans | ■ Wilsonia backhousei |
| | | | | ■ Genoplesium baueri | ■ Pimelea curviflora var. curviflora | |



Source: DECC, 2009; MapData Sciences 2009; Tozer et al, 2006 Native vegetation of southeast NSW

The likelihood of occurrence of these species based on previous records and habitat attributes is summarised in Appendix C of Technical Paper 3. Those species which were considered to have a moderate to high likelihood of occurring within the study area on the basis of distribution and habitat requirements are shown in Table 81.

Table 81 Threatened flora species with potential to occur in the M2 corridor

Scientific name	Common name	Type of species	TSC Act status	EPBC Act status	Likelihood of occurrence
<i>Acacia bynoeana</i>	Bynoe's Wattle	Shrub	E	V	Moderate
<i>Callistemon linearifolius</i>		Shrub	V	-	High
<i>Darwinia biflora</i>	-	Shrub	V	V	Moderate – High
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-	Shrub	V	-	High-recorded
<i>Persoonia hirsuta</i>	Hairy Geebung	Shrub	E	E	Moderate
<i>Pimelea curviflora</i> var. <i>curviflora</i>	-	Shrub	V	V	High
<i>Tetratheca glandulosa</i>	-	Shrub	V	V	Moderate

V = Vulnerable, E = Endangered, - = Not listed

The threatened terrestrial plant species that are considered to have potential to occur within the study area are chiefly those species which are associated with sandstone soils, particularly where these soils are somewhat enriched due to their proximity to areas of shale-derived soil.

Of the above-listed species, the following species have been recorded in the locality and are associated with woodland or open forest on clay-enriched sandstone soils:

- *Callistemon linearifolius*.
- *Darwinia biflora*.
- *Epacris purpurascens* var. *purpurascens*.
- *Pimelea curviflora* var. *curviflora*.
- *Tetratheca glandulosa*.

Of these species, only *Epacris purpurascens* var. *purpurascens* was recorded during the recent field investigations. *Epacris purpurascens* var. *purpurascens* is an erect shrub, 50-180 centimetres high that is found in a range of habitat types, most of which have a strong shale soil influence (DECCW, 2009b). Within the M2 corridor, individuals of this species are located in translocated soils including earth mounds and rock armoured batter slopes.

Pimelea curviflora var. *curviflora* was recorded during the Environmental Impact Statement for the western section of the M2 Motorway (Mount King, 1992). However, this species was not identified in the M2 corridor during the current field surveys. The species has been recorded in Lane Cove National Park and in Epping near the M2 corridor (DECCW 2009). The species was not recorded during recent flora surveys however, it is possible that this species may exist within the M2 corridor.

Callistemon linearifolius is known to occur in the Hornsby, Lane Cove and Ryde local government areas and has been recorded near the M2 corridor at Marsfield (DECC, 2001). The species usually grows in dry sclerophyll forest on the coast and adjacent ranges. The species was not recorded during the flora survey of the M2 corridor however there is a high likelihood that it occurs here.

Darwinia biflora grows in heath on sandstone or in the understorey of woodland on shale-capped ridges. There are records of this species occurring in the northern and north-western suburbs of Sydney, in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai local government areas. The bushland of the M2 corridor and adjacent bushland (such as Bidjigal Reserve and Lane Cove Valley) are not included in the lists of known important populations. The species was not recorded during flora surveys however, it is possible that this species may exist within the M2 corridor.

Tetratheca glandulosa grows in sandy or rocky heath or scrub. The species was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a potentially important population exists.

Several parts of the M2 Motorway are located on ridgetop areas on or adjacent to areas underlain by shale-derived soils. *Personia hirsuta* and *Acacia bynoeana* are associated with woodland or open forest on sandstone soils but are not particularly associated with soils which have a clay influence. Important populations of these species are not considered likely to exist within the M2 corridor.

Terrestrial fauna and fauna habitat of the study area

Large patches of native vegetation

Habitat for a variety of fauna species exists within the remnant vegetation occurring within the M2 corridor and surrounding bushland areas. Trees (for example, *Eucalyptus spp.*, *Angophora spp.*, *Syncarpia spp.* and *Corymbia spp.*), Wattles (*Acacia spp.*) and Banksias (*Banksia spp.*) in particular provide a food source in the form of leaves, sap, nectar, pollen and seed for a number of bird, mammal and insect species.

Threatened species known to use these resources include Grey-headed Flying-fox (*Pteropus poliocephalus*) and Gang-gang Cockatoo (*Callocephalon fimbriatum*). The migratory nectar-feeding birds Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*) may use this resource sporadically or on a seasonal basis but are not considered likely to be regular or frequent visitors to the area based upon database records.

The Powerful Owl (*Ninox strenua*) is also known to hunt and roost in the bushland of the study area and contiguous areas of bushland in the locality and may nest in large tree hollows in the locality. Nest sites are considered most likely to be located in areas containing very large mature hollow-bearing trees, particularly in core bushland areas which are less subject to human disturbance.

Large and medium-sized tree hollows are likely to exist within the larger, more mature trees particularly in mature Blackbutt (*Eucalyptus pilularis*). These larger trees are chiefly found on lower slopes of gullies and along streams where soils are deeper, moister and enriched by silt and organic material that are not considered likely to be affected by the proposed works. Small hollows, fissures and decorticated bark also exist within the trees of the site. These hollows provide potential den, nest and roost sites for a number of small bird, mammal and reptile species.

Smaller hollows may be used by threatened hollow-roosting microbats including, Eastern Freetail-bat (*Mormopterus norfolkensis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

In addition to the microbat species listed above, several other threatened, non hollow-roosting species may forage in the air spaces within and around the vegetation including Large-eared Pied Bat (*Chalinolobus dwyeri*), Little Bentwing-bat (*Miniopterus australis*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Large-footed Myotis (*Myotis adversus*).

The leaf-litter, fallen logs and ground layer vegetation of the ecology study area form potential habitat for ground-dwelling fauna including Echidna (*Tachyglossus aculeatus*), Long-nosed Bandicoot (*Perameles nasuta*), Swamp Wallaby (*Wallabia bicolor*) and a variety of reptile species. These habitat features are also likely to be used for sheltering and foraging for some locally occurring frog species.

Rocky outcrops

Rocky outcrops provide potential sheltering sites for reptiles (lizards and snakes), frogs and small terrestrial mammals. If environmental conditions are conducive, crevices within larger rock outcrops may provide roosting habitat for some species of cave-roosting microbats. Large rock outcrops are abundant within Bidjigal Reserve including some locations on the edge of the M2 corridor. Microbats are also known to use the bridge abutments and culverts associated with the M2 Motorway as roosting habitat.

Wildlife corridors and connectivity

The bushland of the Darling Mills Creek corridor is considered to be the most significant regional habitat link with Berowra Bushland Park in Hornsby and further on to Ku-ring-gai Chase National Park and Brisbane Waters (Upper Parramatta River Catchment Trust, 1999).

Due to its relatively large size and its connectivity with other bushland areas, the bushland of the Darling Mills Creek corridor retains high biodiversity value and potential for fauna movements and genetic exchange. The more intact bushland areas of the sandstone valleys are likely to have the greatest importance as corridors for terrestrial fauna, particularly for species which are less tolerant of disturbed environments.

Despite extensive weed invasion, the narrow bands of riparian vegetation that persist along creeks within cleared areas, are also important as they provide the continuous vegetation cover that is required by some fauna species which do not readily cross cleared lands. Narrow bands of vegetation, such as those often found along roadways, also have some value as movement corridors for more mobile fauna species.

The main wildlife corridors within the M2 corridor include the bushland and disturbed vegetation surrounding Blue Gum Creek, Devlins Creek, Darling Mills Creek and Terrys Creek.

Rapid Fauna Habitat Assessment

In 2008, DECC completed the study 'Rapid Fauna Habitat Assessment of the Sydney Metropolitan Catchment Management Area'. The study provides a catchment-wide assessment of the value of remnant vegetation for native fauna conservation and ranked the larger sites in priority order. Within the M2 corridor there are four sites considered to be of moderate to very high fauna value (DECC 2008). These include:

- The vegetation north of the M2 Motorway to the Cumberland Highway which forms part of the Lane Cove Valley (Figure 29).
- Darling Mills Creek to the north-west (Bidjigal Reserve area).
- Devlins Creek to the north of the M2 Motorway at the Chilworth Recreation Reserve, Cheltenham.
- Quarry Branch Creek to the south-west of the M2 Motorway at Winston Hills.

In the DECC (now DECCW) study, the fauna significance of a site was determined by the following features:

- Habitat connectivity.
- Habitat state or condition.
- Presence of tree hollows.
- Below canopy structural attributes.
- Habitat present considered to comprise priority fauna habitat.
- Future prospects.
- Presence of threatened species and regionally significance species.
- Potential presence of further significant fauna.
- Presence of feral bird species.
- Presence of additional fauna attributes.

Fauna species of conservation significance

Searches of the NPWS Atlas of NSW Wildlife and EPBC Act Protected Matters Search Tool were conducted to determine if any threatened fauna species listed under the TSC Act or EPBC Act have been recorded or are likely to occur in the vicinity of the M2 Motorway. The database revealed that there are a number threatened species recorded or predicted to occur within ten kilometres of the site.

The likelihood of these species occurring in the vicinity of the M2 Motorway was based on previous records, known habitat attributes and the application of the precautionary principle. Refer to Appendix C of Technical Paper 3 for further detail. Those species which were assessed to have a moderate to high likelihood of occurring on the site on the basis of distribution and habitat requirements are shown in Table 82. Assessments of Significance for these species are presented in Appendix F of Technical Paper 3.

Table 82 Potential threatened fauna species and populations in the M2 corridor

Scientific name	Common name	Type of species	TSC Act status	EPBC Act status	Likelihood of occurrence
<i>Anthochaera phrygia</i>	Regent Honeyeater	Bird	E	E	Moderate
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Bird	V	-	High - recorded
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	Bird	E	-	High - recorded
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Mammal	V	V	Moderate
<i>Calyptorhynchus lathamii</i>	Glossy Black-cockatoo	Bird	V	-	Moderate
<i>Lathamus discolor</i>	Swift Parrot	Bird	E	E	Moderate – seasonal migrant
<i>Litoria aurea</i>	Green and Golden Bell Frog	Frog	E		Moderate
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Mammal	V	-	Moderate to High
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	Mammal	V	-	Moderate to High

Scientific name	Common name	Type of species	TSC Act status	EPBC Act status	Likelihood of occurrence
<i>Myotis adversus</i>	Large-footed Myotis	Mammal	V	-	Moderate to High
<i>Ninox strenua</i>	Powerful Owl	Bird	V	-	Moderate to High
<i>Pseudophryne australis</i>	Red-crowned Toadlet	Frog	V	-	Moderate to High
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Mammal	V	V	High - recorded
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	Mammal	V	-	Moderate
<i>Scoteanax rueppellii</i>	Greater Broad-nosed bat	Mammal	V	-	Moderate to High
V = Vulnerable, E = Endangered, - = Not listed					

The threatened fauna species listed in Table 82 above are discussed in further detail in Section 9.5.3.

Aquatic vegetation communities and condition

The Sandstone Riparian Scrub vegetation type occurs along creeks within and adjacent to the M2 corridor with the most intact occurrences at Darling Mills Creek and Terrys Creek. Much of this vegetation is highly modified as a result of alteration to natural flow regimes, increased nutrients and especially weed invasion.

Native aquatic submerged and emergent vegetation is not abundant within the creeks of the study area. This is likely to be as a result of the chiefly rocky substrate found here, high water velocity during heavy rainfall and competition from introduced species.

The only commonly encountered native aquatic plants were Bull Rush (*Typha orientalis*) and knotweeds (*Persicaria spp.*), which were found in small patches along the creeks and primarily in disturbed areas. The detention basins within the M2 corridor contain an artificial assemblage of emergent native aquatic plants including *Eleocharis sphacelata*, Marsh Club-rush (*Bolboschoenus fluviatilis*) and Jointed Twig-rush (*Baumea articulata*), which were planted when the basins were constructed. No assemblages of native aquatic plants were found that could be described as native vegetation communities.

Aquatic fauna habitat

Waterways

Prior to residential development in surrounding areas, the creeks of the locality are likely to have supported a diverse community of insects, fish, frogs, birds and mammals. The creeks are degraded to varying degrees as a result of a number of factors including increased erosion due to the concentration of stormwater flows, weed invasion, polluted catchment runoff and the presence of exotic fish species. As a result of this condition, frogs, fish and aquatic invertebrates that are sensitive to these forms of disturbance are unlikely to persist in these waterways. Nonetheless, a variety of disturbance tolerant fauna species remain.

The present condition of the creeks within the M2 corridor varies from highly modified to near-natural. Classification of the creeks within the study area is listed below in Table 83.

Table 83 Classification of waterway crossings within the study area

Classification	Characteristics of waterway type	Creek/drainage line
Class 2 – Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.	Darling Mills Creek
Class 3 – Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (for example, fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.	Blue Gum Creek, Devlins Creek and Terrys Creek

Source: Fairfull, S. and Witheridge, G. (2003) *Why do Fish Need to Cross the Road?*

The section of Darling Mills Creek crossed by the M2 corridor appears to be in moderate condition, with low turbidity, little evidence of sedimentation and a low level of weed invasion. This drainage line is likely to provide habitat for a range of native fish species as listed below in Table 84, which identifies the fish species that were recorded during previous surveys or are considered likely to occur within the study area.

Table 84 Fish species considered likely to occur within the study area

Scientific name	Common name	Conservation status (NSW)
<i>Anguilla australis</i>	Short-finned Eel	P
<i>Anguilla reinhardtii</i>	Long-finned Eel	P
<i>Carassius auratus</i>	Goldfish	U
<i>Cyprinus carpio</i>	Common carp	U
<i>Gobiomorphus australis</i>	Striped Gudgeon	-
<i>Gobiomorphus coxii</i>	Cox Gudgeon	-
<i>Hypseleotris compressus</i>	Empire Gudgeon	-
<i>Hypseleotris galii</i>	Firetail Gudgeon	-
<i>Philypnodon grandiceps</i>	Flathead Gudgeon	-
<i>Galaxias maculatus</i>	Common Jollytail	-
<i>Gambusia affinis</i>	Mosquito fish	U
<i>Retropinna semoni</i>	Australian Smelt	-

Note: P: Protected; U: Unprotected; -: Not classified.

It is also likely to be inhabited by the introduced Plague Minnow (*Gambusia holbrooki*), though the population density of this species is likely to be relatively low due to the higher water quality and intact riparian vegetation which favour native fish species. The Eastern snake-necked Tortoise (*Chelodina longicollis*) is also likely to be found here.

Recent frog surveys conducted along this section of Darling Mills Creek detected common species such as the Green Stream Frog (*Litoria phyllochroa*), Peron's Tree Frog (*Litoria peronii*), Striped Marsh Frog (*Limnodynates peronii*) and Common Eastern Froglet (*Crinia signifera*).

The threatened Red-crowned Toadlet (*Pseudophryne australis*) usually lives close to non-perennial streams but previous ecological assessments conducted have recorded the Red-crowned Toadlet between Wicks Road and Epping Road, North Ryde, adjacent to the M2 corridor (Eco Logical Australia, 2009 and Biosphere, 2007) and also at Nile Close, Marsfield. The North Ryde area is occupied by Transport Infrastructure Development Corporation (TIDC) and is currently proposed as a compound site for the upgrade of the M2 Motorway.

The other creeks of the study area are more disturbed and are likely to contain a lower diversity and abundance of fish and frog species with the Plague Minnow becoming increasingly dominant in more disturbed areas.

A number of fish species likely to be found within the creeks of the study area are catadromous, meaning they spend their lives in freshwater and return to the ocean to spawn. Catadromous species likely to be found in the creeks of the study area include:

- Shortfinned Eel (*Anguilla australis*).
- Longfinned Eel (*Anguilla reinhardtii*).
- Common Jollytail (*Galaxias maculatus*).

These species need to be able to move between freshwater and marine environments and thus may be susceptible to the obstruction of waterways. Other fish species which move into the smaller tributaries of river systems during the juvenile phase of their life cycles may also be susceptible.

Obstructions to fish movement within the M2 corridor exist where waterways pass beneath the M2 Motorway via culverts. During low flow conditions, the streams of water flowing through the culverts are broad but very shallow and may limit the passage of some fish species. Higher water velocity and turbulence during rainfall events and a lack of pooled areas for fish to rest between bouts of swimming may also limit fish movement through the culverts. The extremely low light level within culverts may also create a nonphysical barrier for some fish species that may avoid dark areas during daylight hours (Fairfull and Witheridge, 2003).

Larger in stream structures (for example, the retarding basin wall near Loyalty Road, North Rocks and weirs on the Lane Cove River) lower in the catchments of these creeks are also potential barriers to fish passage. Prior to the 1980's the Platypus (*Ornithorhynchus anatinus*) was regularly observed within Darling Mills Creek in Bidjigal Reserve but has not been seen in recent times. The Water Rat (*Hydromys chrysogaster*) has previously been recorded and may still occur in the waterways of the study area.

Constructed water bodies (detention basins)

When constructed, the detention basins of the M2 corridor were planted with emergent aquatic native plants with the intention of providing wildlife habitat. This was in addition to the primary purpose of slowing stormwater flows to minimise water pollution and impacts to the hydrology of adjacent waterways.

Emergent aquatic plants currently found growing in the detention basins include *Eleocharis sphacelata*, *Bolboschoenus fluviatilis*, and *Typha orientalis*. Four frog species were recorded within the detention basins; *Litoria peronii*, *L. fallax*, *Limnodynastes peronii* and *Crinia signifera*.

The detention basins vary somewhat in the characteristics of the aquatic vegetation found within them, some having an almost complete cover of emergent vegetation whilst others have larger areas of open water. The height and structure of the vegetation surrounding the basins also varies with some overshadowed by tree regrowth and others in relatively open sunlit conditions. Water levels within these basins are likely to increase after rainfall and decrease during extended dry periods though it is likely that water is continually present in most, if not all, of these basins.

Water quality in the basins is likely to be relatively poor due to the influx of pollutants from the road surface. Basins that are isolated from other water bodies are unlikely to be inhabited by fish though other aquatic fauna such as tortoises, snakes and wading birds may be found in these locations. It is unknown whether or not the Amphibian Chytrid Fungus is found in any of these basins, but it is possible that it may have been introduced there by colonising frogs.

Feral animals and over-abundant native species

Introduced feral and domestic predatory mammal species such as the European Red Fox (*Vulpes vulpes*), Domestic Cat (*Felis catus*) and Black Rat (*Rattus rattus*) compete with and prey upon native fauna and may have led to the local depletion or extinction of small to medium-sized terrestrial mammals, ground-foraging birds and reptile species.

Other introduced species such as the European Rabbit (*Oryctolagus cuniculus*) may damage plants and fauna habitat through their feeding and digging activities. A number of introduced birds such as the Red-whiskered Bulbul (*Pycnonotus jocosus*) spread the seeds of environmental weeds. Common Myna (*Acridotheres tristis*), Starling (*Turdus merula*) and European Honey Bee (*Apis mellifera*) compete with native species for nesting hollows.

Several native bird species are believed to have increased markedly in their abundance and have been implicated in the decline of some common native species due to competition and predation. Noisy Miner (*Manorina melanophrys*), Rainbow Lorikeet (*Trichoglossus haematodus*) and Red Wattlebird (*Anthochaera carunculata*) are aggressive nectar-feeding species which may exclude other nectar-feeding birds from flowering trees and shrubs. Pied Currawong (*Strepera graculina*) have been implicated in the decline of populations of small birds as a result of the predation, particularly of eggs and nestlings and also spread the seeds of environmental weeds. Parrots such as Sulphur-crested Cockatoo (*Cacatua galerita*) and Rainbow Lorikeet (*Trichoglossus haematodus*) compete with other birds for scarce nesting opportunities in tree hollows.

Many of these species have been able to establish and proliferate in bushland areas as a result of human-induced changes to the environment such as vegetation clearing and the cultivation of introduced plant species.

9.5.3 Impact assessment

Impacts on flora

Loss of native vegetation

The project would require clearing of native vegetation for:

- Areas occupied by the widened Motorway and fill batters.
- Establishment of construction access roads.
- Establishment of construction compound sites.
- Establishment of materials storage areas.
- Construction of new detention basins.
- Facilitation of access to detention basins.

The nature of these impacts is summarised in Table 85.

Table 85 Direct impacts on vegetation

Element of upgrade	Nature of impact
Widened M2 Motorway including fill batters.	<ul style="list-style-type: none"> Permanent removal of vegetation would occur in areas occupied by the widened M2 Motorway. Permanent alteration of the soils of the batter slopes would occur.
Construction access roads and materials storage areas.	<ul style="list-style-type: none"> Partial clearing of vegetation would occur in the areas identified for construction access roads. Vegetation removal would be limited to that necessary for access. Mature trees and other fauna habitat features such as waterways and rock outcrops would be avoided where practicable. Access roads to compound sites and work locations associated with bridges over Darling Mills Creek, Devlins Creek and Terrys Creeks would be required. Darling Mills Creek would be accessed via access tracks off the M2 Motorway. Entry to the compound site would be via eastbound lanes and exits would be via westbound lanes. Devlins Creek would be accessed via Allerton Road (entry and exit). Terrys Creek would be accessed via access tracks provided off Somerset Street (entry and exit). Areas under the bridges would be utilised for access. Construction methodology would be determined during the detailed design phase. Cleared areas would be rehabilitated post construction.
Construction compound sites.	<ul style="list-style-type: none"> Clearing of vegetation would occur in the areas identified for construction compound sites. The larger construction compound sites are located on filled areas. Vegetation in these areas is composed of trees and shrubs planted after the construction of the M2 Motorway with the ground layer consisting almost entirely of introduced species.
New detention basins including access roads.	<ul style="list-style-type: none"> Permanent removal of vegetation in areas occupied by the new detention basins and access roads. Detention basins would be planted with emergent native aquatic plant species.
Access to existing detention basins.	<ul style="list-style-type: none"> Permanent removal of vegetation for permanent access roads to access new and existing detention basins. Works would involve permanent removal of vegetation, much of which is weedy regrowth from the original construction of the basins.

The proposed widening of the M2 Motorway has been designed to minimise the amount of vegetation removal required. Design options have been considered to reduce the amount of excavation and intensive earthworks that would be required and therefore minimise the potential impacts to the surrounding environment. Wherever practicable the proposed widening has been designed within the existing footprint of the M2 Motorway. This includes site compound locations (refer to Sections 7.8.1 and 9.8 for further discussion regarding the approach to selecting preferred compound locations) and proposed access and egress routes. At the Devlins Creek viaduct, approximately 60 percent of the additional road width requirements are proposed to be provided by joining the two adjacent bridge decks. This would minimise disturbance in the riparian zone. An already stripped site previously used as a construction compound has been chosen for the proposed main construction compound, within the Macquarie Park precinct.

The amount of vegetation (native and exotic) estimated to be cleared is approximately 21 hectares in total. A conservative estimate of the amount of vegetation considered to be in good condition within the study area is approximately ten hectares. These areas are characterised by having a relatively intact understorey, shrub and canopy layer and are consistent with the floristic composition of the vegetation community as defined by the relevant native vegetation classification for each community.

Approximately 11 hectares of the total vegetation to be cleared is in poor condition as these areas are highly modified and characterised by high levels of weed invasion. Table 86 shows the breakdown of clearing required in each vegetation community. The vegetation communities are those described by the

predictive vegetation mapping datasets within the M2 corridor. The local occurrence of the vegetation communities is defined as the ecological community that occurs within and adjacent to the study area.

Table 86 Vegetation clearing within the M2 corridor

Vegetation community	A	B	C
	Approximate local occurrence (hectares)	Approximate amount of vegetation removal (hectares)	Approximate amount of the vegetation in Column B that is disturbed/exotic (hectares)
Coastal Sandstone Ridgetop Woodland	25.2	0.4	0.16
Hinterland Sandstone Gully Forest	379.6	17.5	9.3
Sydney Hinterland Transition Woodland	24.4	0.1	0.08
Sandstone Riparian Scrub	64.5	3	1.3
Total		21	10.84

Potential impacts to threatened flora species considered to have a moderate to high likelihood of occurrence are summarised below.

Acacia bynoeana

Acacia bynoeana occurs in heath or dry sclerophyll forest on sandy soils and generally prefers open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and recently burnt patches. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leafed Apple. The total population is estimated to be only a few hundred plants. The closest records of the species to the M2 corridor are within two kilometres in Gordon and near the northern boundary of Bidjigal Reserve. No individuals of this species were recorded within the M2 corridor during recent flora surveys.

An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. The M2 Upgrade project is unlikely to have a significant impact on a local population of *Acacia bynoeana*. As the potential habitat here is isolated from habitat containing known populations in the region as a result of urban development it is considered unlikely that any population here would be considered a key source population either for breeding or dispersal.

Callistemon linearifolius

Callistemon linearifolius has been recorded within the M2 corridor at Marsfield (DECCW, 2001). The species was not detected during the flora survey of the M2 corridor. An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. The M2 Upgrade project is unlikely to have a significant impact on a local population of *Callistemon linearifolius* and with the implementation of the mitigation measures provided in Section 9.5.4 (such as pre-clearance surveys prior to construction), potential impacts to this species would be minimised.

Darwinia biflora

There are 20 populations of *Darwinia biflora* within the Sydney Region that are not currently covered by the reserve system and have been identified as important and suitable to be targeted for conservation. None of these important populations are located within the bushland of the M2 corridor or adjacent bushland (for example Bidjigal Reserve, Lane Cove National Park).

The species was not recorded during flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely that a large population exists here.

An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. The M2 Upgrade project is unlikely to have a significant impact on a local population of *Darwinia biflora* as it is considered unlikely that a large population exists here.

Epacris purpurascens var. purpurascens

Epacris purpurascens var. *purpurascens* habitats which remain (particularly on ridgetops) are under increasing threat of clearance or habitat modification (DECCW, 2009b).

A conservative estimate of potential habitat for *Epacris purpurascens* var. *purpurascens* within the M2 corridor is approximately 30 hectares. Approximately 20 individuals of this species (observed in flora plots during flora surveys) are likely to be removed (refer to Figure 31). As these individuals of the species are located in translocated soils and earth mounds within the M2 corridor, further regeneration of the species from soils translocated during the proposed project is considered likely.

An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. Based on the above considerations and assessment conducted, the project is unlikely to have a significant impact on a local population of *Epacris purpurascens* var. *purpurascens*.

Persoonia hirsuta

Persoonia hirsuta was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, the closest recent (post 1980) record of the species is approximately five kilometres from the M2 corridor and the species has not been detected within the adjacent bushland reserves.

An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. The proposed works are unlikely to have a significant impact on this species as a potentially important population is not considered likely to exist within the M2 corridor.

Pimelea curviflora var. curviflora

Pimelea curviflora var. *curviflora* was recorded during the EIS for the western section of the M2 Motorway (Mount King 1992) however the specific location and the population size of this species were not reported. It is found in two fairly small populations in Lane Cove National Park, North Ryde and a few plants were recorded in the Pages Creek area. The Field of Mars Reserve population was estimated to be greater than 300 plants. The species is known to also occur at Epping Oval (DECCW, 2001).

An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. The M2 Upgrade project is unlikely to have a significant impact on a local population of *Pimelea curviflora* var. *curviflora*.

Tetratheca glandulosa

Tetratheca glandulosa is associated with areas of shale-sandstone transition habitat. The vegetation varies from heaths and scrub to woodlands/open woodlands, and open forest. The species was not recorded during recent flora surveys within the M2 corridor. Whilst it is considered possible that this species may exist within the M2 corridor, it is considered unlikely due to the level of disturbance occurring in these areas.

An assessment of significance for the potential impact on this species has been undertaken and is presented in Appendix F of Technical Paper 3. The M2 Upgrade project is unlikely to have a significant impact on a local population of *Tetratheca glandulosa* as it is considered unlikely that a potentially important population exists within the development footprint.

Indirect impacts and edge effects

The Blue Gum High Forest community is listed as a CEEC under the TSC Act and the EPBC Act. The extent and condition of this community has been verified through on ground inspection and the present distribution within the M2 corridor is restricted to a narrow band between the M2 Motorway and Pennant Hills Golf Course to the north. This area is approximately 1.36 hectares in area and in moderate to poor condition.

The design option for the proposed widening of the M2 Motorway was specifically chosen to avoid vegetation clearing or modification to this ecological community, however indirect impacts are possible.

The earthworks required for the construction of the project have the potential to spread weed seeds between locations along the length of the M2 corridor in soil adhered to vehicles and construction equipment and on the clothing of construction workers. Soil disturbance as a result of earthworks activities may also create a favourable environment for the proliferation of weed species already present.

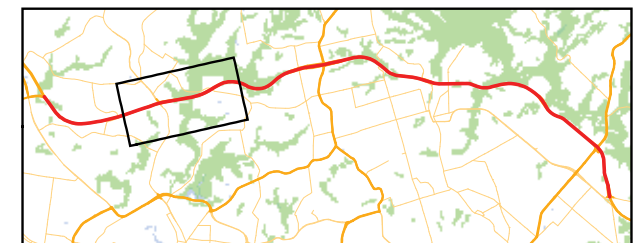
Shading and the reduction in soil moisture due to the interception of rainfall by overbridges has the potential to alter the structure and composition of vegetation beneath these structures.

An assessment of significance for the potential impact on Blue Gum High Forest has been undertaken and is presented in Appendix F of Technical Paper 3. This assessment concludes that the M2 Upgrade project is not likely to result in significant impact on this community.



0 125 250 500 m
 Figure 31 – Approximate locations of *Epacris purpurascens* var. *purpurascens*

- Lease boundary
- Proposed Design
- ▨ *Epacris purpurascens* var. *purpurascens*



Impacts on fauna

Measures would be implemented to minimise the risk of harm to native fauna during construction activities. Detailed consideration of the impacts of the project on threatened species is provided in the Assessments of Significance in Appendix F of Technical Paper 3.

Fauna species assessed

Species assessed include:

- Green and Golden Bell Frog (*Litoria aurea*).
- Red-crowned Toadlet (*Pseudophryne australis*).
- Gang-gang Cockatoo (*Callocephalon fimbriatum*).
- Glossy Black-cockatoo (*Calyptorhynchus lathamii*)
- Powerful Owl (*Ninox strenua*).
- Regent Honeyeater (*Anthochaera phrygia*).
- Swift Parrot (*Lathamus discolor*).
- Grey-headed Flying-fox (*Pteropus poliocephalus*).
- Several species of microbats such as:
 - Eastern Freetail-bat (*Mormopterus norfolkensis*),
 - Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*),
 - Greater Broad-nosed Bat (*Scoteanax rueppellii*),
 - Eastern Bentwing-Bat (*Miniopterus schreibersii oceanensis*),
 - Large-footed Myotis (*Myotis adversus*), and
 - Large-eared Pied Bat (*Chalinolobus dwyeri*).

Migratory species assessed include:

- Black-faced Monarch *Monarcha melanopsis*.
- Rainbow Bee-eater *Merops ornatus*.
- Rufous Fantail *Rhipidura rufifrons*.
- Satin Flycatcher *Myiagra cyanoleuca*.
- White-throated Needletail *Hirundapus caudacutus*.

These species are discussed in the following subsections.

Green and Golden Bell Frog

While some of this area is considered to be potential foraging habitat for this species, most of this area is considered to be marginal or unsuitable as habitat due to a lack of suitable vegetation cover, dry surface conditions and distance from potential breeding habitat. Modification to these areas as a result of clearing may result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term.

Assessments of significance (provided in Appendix F) concluded that a significant adverse impact on the Green and Golden Bell Frog is unlikely.

Red-crowned Toadlet

Although the Red-crowned Toadlet was not recorded during current surveys within the M2 corridor, this species has been recorded between Wicks Road and Epping Road, North Ryde, adjacent to the M2 corridor (Eco Logical Australia, 2009 and Biosphere, 2007), and also at Nile Close, Marsfield. The North Ryde area is occupied by Transport Infrastructure Development Corporation (TIDC) and is currently proposed as a compound site for the M2 Upgrade project.

Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat. Much of the widening works are not in close proximity to breeding areas of the Red-crowned Toadlet and are considered to be at best, marginal as habitat for the species.

Assessments of significance (provided in Appendix F) concluded that a significant adverse impact on the Red-crowned Toadlet is unlikely.

Gang-Gang Cockatoo

The Gang-gang Cockatoo was recorded during the current study flying overhead in the vicinity of the Terry Creek overpass near Crimea Road on the border of Epping and Marsfield.

A population of Gang-gang Cockatoos persists in the Hornsby and Kur-ing-gai Local Government Areas and is largely believed to be confined to an area bounded by Thornleigh and Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west and Turramurra/South Turramurra to the east (DECCW, 2009). The population encompasses, but is not restricted to, Pennant Hills Park and parts of Lane Cove National Park.

Given the proximity of the existing M2 Motorway to the vegetation that would be affected, it is considered unlikely that sites used for breeding by this species would be affected. Potential nesting hollows for the species are not known or considered likely to be abundant in the area affected by the proposed M2 Upgrade project. No hollows of sufficient size to accommodate the species were observed in any of the trees that would be removed.

An assessment of significance (provided in Appendix F) concluded the proposed M2 Upgrade is unlikely to have a significant adverse impact on the Gang-gang Cockatoo is unlikely.

Glossy Black Cockatoo

This species depends on large hollow-bearing eucalypts for nest sites and feeds exclusively on the seeds of several species of She-oak (*Casuarina* and *Allocasuarina* species). No hollows of sufficient size to accommodate the species were observed in any of the trees that would be removed as a result of the M2 Upgrade project.

These birds are highly mobile species with large home ranges and the small linear patch of vegetation removal that is proposed would not significantly increase habitat fragmentation for these species.

Due to their ability to fly, the bird species may forage within the vegetation along the M2 corridor but most are likely only as occasional visitors to these areas with their core habitat being within larger more intact areas of vegetation in the locality.

An assessment of significance (provided in Appendix F) concluded a significant impact on the Glossy Black Cockatoo is unlikely.

Grey-headed Flying Fox

The Grey-headed Flying-fox was recorded flying overhead in several locations during field surveys. Individuals feeding within the study area are considered most likely to roost in the Ku-ring-gai Flying-fox Reserve in Gordon.

Foraging habitat for this species is considered to be present throughout the study area wherever fleshy-fruited and nectar-producing trees are present and forages throughout the Sydney Metropolitan area. No camp sites are present within or in the bushland adjacent to the M2 corridor.

Modification and vegetation clearing as a result of the M2 Upgrade project would result in a reduction in available foraging habitat in the short-term but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation would be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Assessments of significance (provided in Appendix F) concluded that a significant impact on the Grey-headed Flying-fox is unlikely.

Powerful Owl

The Powerful Owl requires large tracts of forest or woodland habitat but can also occur in fragmented landscapes (DEC, 2006). This species is known to nest in large tree hollows (at least 0.5 m deep), in large eucalypts that are at least 150 years old (DECCW, 2009) and some of their prey also rely on tree hollows for refuge.

No hollows of sufficient size to accommodate the species were observed in any of the trees that would be removed. The majority of the trees to be removed are relatively small due to low nutrient and moisture levels, previous clearing for the existing M2 Motorway and the logging history of the area.

Assessments of significance (provided in Appendix F) concluded that a significant adverse impact on the Powerful Owl is unlikely.

Regent Honeyeater

The Regent Honeyeater generally inhabits dry, temperate woodlands and open forests of the inland slopes of south-eastern Australia (DECCW, 2009). There are only three known major breeding locations and two of these occur in NSW.

Breeding of the species has not been recorded in the Sydney area and breeding of the species in the vicinity of the M2 corridor is considered highly unlikely. A reduction in available foraging habitat in the short-term would occur but is not considered likely to prevent the species from using these areas as foraging sites in the medium to long term. Although this vegetation would be removed, upon completion of works the vegetation would be allowed to regenerate naturally and would be supplemented by revegetation and bushland regeneration works.

Assessments of significance (provided in Appendix F) concluded that a significant adverse impact on the Regent Honeyeater is unlikely.

Swift Parrot

Favoured feed trees of the Swift Parrot are wintering flowering eucalypts. Little of this vegetation remains however revegetation along the edges of the M2 Motorway has involved in the planting of some individuals of these species. This revegetation consists of narrow bands of immature trees between the edge of the M2 Motorway and adjacent residential lands.

Given the lack of breeding habitat and the relatively small amount of marginal potential foraging habitat that would be affected, the M2 Upgrade project is not considered likely to significantly disrupt the breeding cycle of any subset of the population of the Swift Parrot.

Assessments of significance (provided in Appendix F) concluded that a significant adverse impact on the Swift Parrot is unlikely.

Insectivorous (microchiropteran) bats

The study area does not contain any caves, or mines near or above water and is consequently unlikely to provide preferred roosting or maternity sites for many of the threatened microbat species listed above. Preferred habitat for the threatened microbat species is likely to be found lower within moister valleys of the locality rather than the upper slope areas in which the M2 Motorway is chiefly located. Species such as the Eastern False Pipistrelle are not considered to occur within the study area as they prefer moist habitats in vegetation characterised with tree species over 20 metres (DECCW, 2009).

The core likely foraging habitat for threatened microbats in the locality is concentrated in the larger areas of more mature vegetation that would not be substantially affected by the proposed works. The habitat affected by the proposed works is of marginal quality due to previous clearing, weed invasion and traffic noise. Due to the lack of suitable roosting habitat, and disturbance, this area is considered to be of relatively low value as potential habitat for the threatened microbat species listed above when compared to larger areas of vegetation at greater distance from the M2 Motorway.

The conclusions of the assessments are that a significant adverse impact on the above insectivorous microbat species is considered unlikely,

Migratory Species

Migratory species are considered unlikely to rely on the affected areas as breeding, foraging or roosting habitat due to the level of disturbance adjacent to the M2 Motorway. Breeding habitat is more likely to be located in core bushland areas beyond the study area. Suitable foraging habitat is only considered to be marginal at best with preferred habitat more likely to be located in areas of less-disturbed habitat in the locality. Assessments of significance (provided in Appendix F) concluded that a significant adverse impact on migratory species is unlikely.

Fauna habitat loss

The main direct impact on fauna is habitat removal. The works would cause a reduction in habitat available for native fauna species through the removal of native vegetation and habitat features such as rock outcrops and organic debris. The extent of habitat removal is likely to total approximately 21 hectares, of which, three hectares would be subsequently rehabilitated.

Vegetation removal (particularly native vegetation) has the potential to impact on fauna species through a reduction in the availability of feeding resources, shelter from environmental extremes, refuge from predators and breeding sites. Whilst removal of vegetation within the development footprint would be

permanent, clearing for access and compound areas would be temporary as these areas would be rehabilitated post-construction.

No tree hollows of sufficient size to provide nesting opportunities for larger hollow-dependant species were observed within the areas potentially affected by clearing activities. Most of the trees removed are immature or semi-mature, but have the potential to develop hollows as they mature, providing opportunities for populations of hollow-dependent fauna to recover. The mitigation measures proposed include the installation of nest boxes to compensate for the loss of potential hollow-bearing trees.

Lighting impacts

Construction lighting would be required for works carried out at night-time (sunset-sunrise), especially during the winter months. Four proposed compound sites would be operational 24 hours per day. These compounds are discussed in detail in Section 10.8.

Light spill would occur at the locations of the proposed compound sites. Potential impacts to fauna resulting from light spill would be greatest adjacent to larger areas of bushland reserves, such as the proposed Terrys Creek Compound and the Darling Mills Creek Compound.

Nocturnal species are adapted to low light conditions to forage for food and may therefore be deterred from foraging areas as a result of excessive light spill. Nocturnal mammals and birds are also likely to be disturbed by artificial light at night-time as they are at an increased risk from predators.

The regular route of threatened bat species may also be affected as a result of light spill. The Grey-headed Flying-fox was recorded flying overhead in several locations and individuals feeding within the study area are considered most likely to roost in the Ku-ring-gai Flying-fox Reserve in Gordon. The study area does not contain camp sites for the Grey-headed Flying-fox and although vegetation in parts of the M2 corridor may be suitable for roosting, the presence of the M2 Motorway and walking trails with associated noise and light disturbances is considered likely to dissuade the species from roosting in these areas.

Potential impacts may occur to threatened insectivorous bat species, however species such as the Large-footed Myotis (*Myotis adversus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*) are more likely to be found lower within the moister valleys of the locality rather than the upper slope areas in which the M2 Motorway and potential construction compound sites are chiefly located. Therefore, roosting and breeding habit for these species is considered unlikely to be affected by the increase in lighting as a result of the proposed project. The potential impacts to threatened bat species as a result of light spill are considered to be less likely during the winter months when foraging activities decline.

The increase in some species of insects attracted to light sources, such as moths, may be beneficial to some threatened insectivorous bat species that are high speed aerial foragers such as the Eastern Bentwing-Bat and Yellow-bellied Sheathtail-Bat.

Light mitigation would be addressed during the detail design stage to develop appropriate light spill management strategies, including measures such as correctly positioned and aimed floodlights and screening of compound areas for the control of construction vehicle headlamp impacts. Careful design and selection of luminaries is considered likely to minimise the impacts on fauna.

The existing M2 Motorway is lit and the proposed upgrade works would not result in significant additional light spill impacts beyond those already occurring.

Indirect impacts and edge effects

A total of 21 hectares of vegetation would be cleared as a result of the project. Of the 21 hectares, 18 hectares would be within the development footprint and vegetation removal would be permanent. The remaining three hectares would be cleared for access and construction compound sites and would be rehabilitated post construction. Mature trees would be avoided where practicable in areas proposed for rehabilitation. Within this, the vegetation types that occur comprise Hinterland Sandstone Gully Forest and Sandstone Riparian Scrub. These communities are not listed as threatened ecological communities under the EPBC Act or TSC Act.

Alteration to fauna movement (wildlife) corridors may occur as a result of the works. The main wildlife corridors within the M2 corridor include the bushland and disturbed vegetation surrounding Blue Gum Creek, Devlins Creek, Darling Mills Creek and Terrys Creek.

Where bridge structures span Darling Mills Creek, Devlins Creek and Terrys Creek, the vegetation underneath forms the only habitat connection between bushland areas on opposite sides of the M2 Motorway. These areas are considered to be of particular importance to fauna movement. The vegetation underneath these structures is somewhat degraded due to previous earthworks, the impacts of shading and the interception of rainfall by the roadway overhead.

Closing the existing gap between the two bridge structures across Devlins Creek and widening to the south is the preferred option to minimise the potential impacts on the surrounding environment and avoid the need to construct two new culverts which would impact on the water quality of the Creek during construction.

Bridges and arch structures generally have the least impact on fish passage as they normally involve limited disturbance to the flow or the aquatic habitat of a waterway (Fairfull and Witheridge, 2003). The proposed widening of the bridge structures over each of these creeks has the potential to result in further degradation of riparian vegetation of these areas and hence limits their ability to act as movement corridors for terrestrial species due to shading and the reduction in soil moisture.

Fish passage can be adversely affected by the following conditions (Fairfull and Witheridge, 2003):

- Large scale turbulence resulting from bridge piers.
- Changes to in-stream and bank vegetation affecting water shading.
- Degraded aquatic habitat value.
- High water velocities and increased flood flow velocities.

The potential impact of the bridge piers may also result in localised changes to flow patterns and localised scour. Due to the sandy nature of soil under bridges, the construction of piers may result in increased erosion and sedimentation during the construction phase however erosion control plans would be implemented and these areas would be remediated (revegetated) or stabilised post-construction. The design and construction considerations for bridges and arches have been included in the mitigation measures detailed in Section 9.5.4.

The extension of culverts may also affect the passage of fish and other aquatic fauna. The most common fish passage problems associated with culverts include: excessive flow velocities within the culvert, inadequate flow depth within the culvert and debris blockage of the culvert (Fairfull and Witheridge, 2003). As the existing culverts present a potential constraint to fish movement, the extension of these barriers is unlikely to substantially alter the current situation.

Degradation of fauna habitat as a result of weed invasion and proliferation is a potential impact of the proposed works. Weed dominance may result in a reduction in plant species which are important as habitat for native wildlife. Weed thickets may harbour feral animals such as foxes and rabbits. With the

implementation of the proposed weed management and vegetation rehabilitation measures it is considered that weed proliferation in relation to the project could be adequately managed.

Other operational impacts

Once constructed, there may be additional run-off from the upgraded M2 Motorway, which has the potential to result in indirect impacts to vegetation through erosion of soils, sedimentation of waterways and the potential movement of pollutants. As described in the Technical Paper 6, *M2 Upgrade Environmental Assessment – Surface Water Assessment* (AECOM, 2010), the existing water quality basins would be modified as required to account for significant changes in contributing catchment area or to meet the target pollutant reduction criteria. Due to the constrained project corridor, and in an effort to minimise further disturbance of the established vegetation, wherever practical it is proposed to modify the inlet/outlet details of the existing basins to better utilise the storage volume already available by increasing the ponded (extended) depth.

There are not expected to be other significant additional impacts above and beyond the current M2 Motorway operation.

Significance of impacts

Assessments of significance were conducted for threatened flora and fauna species considered to have a moderate to high likelihood of occurrence, as described in Table 81 and Table 82. For those species listed under the NSW TSC Act, the significance of impact was undertaken in accordance with the heads of consideration as outlined in the *Draft Guidelines for Threatened Species Assessment* by the Department of Environment and Conservation and the Department of Primary Industries, 2005 (DEC and DPI, 2005). For those species listed as threatened or migratory under the provisions of the EPBC Act, potential impacts were assessed in accordance with the *Significant Impact Guidelines and Matters of National Significance* outlined by the Department of Environment and Heritage (DEH, 2006).

Based on assessments of significance conducted (refer to Appendix F of Technical Paper 3), it is not considered likely that the proposed works would have a significant impact on threatened flora or fauna species listed in Table 81 and Table 82.

Of the threatened terrestrial plant species that are considered to have potential to occur within the areas adjacent to the M2 Motorway, only *Epacris purpurascens* var. *purpurascens* was recorded during the field investigations conducted for the preparation of this report. Although this species is not listed as threatened under the EPBC Act, it is listed as vulnerable under the TSC Act. Individuals of this species found to be present were located in translocated soils including earth mounds and rock armoured batter slopes within the M2 corridor. An assessment of significance for the potential impact on this species concluded that the proposed works are unlikely to have a significant on this species.

The following species have also been recorded in the locality however were not recorded during recent flora surveys within the M2 corridor:

- *Callistemon linearifolius*.
- *Darwinia biflora*.
- *Epacris purpurascens* var. *purpurascens*.
- *Persoonia hirsute*.
- *Pimelea curviflora* var. *curviflora*.
- *Tetratheca glandulosa*.

Assessments of significance conducted, concluded that the potential impacts on the above listed species are not considered to be significant.

The M2 Upgrade project is not considered to have a significant impact on EPBC Act and TSC Act listed threatened ecological communities. The assessment of significance for the Blue Gum High Forest community has concluded that potential impacts on this community are not considered to be significant. The vegetation within the M2 corridor that is mapped (refer to Section 9.5.2 for description of mapping) as Sydney Turpentine – Ironbark Forest is considered to be Hinterland Sandstone Gully Forest, which is not a listed threatened community, therefore an assessment of significance has not been conducted for this community. Habitat for a variety of fauna species exists within the remnant vegetation occurring within the M2 corridor and surrounding bushland areas.

Threatened species with a moderate to high likelihood of using these areas include Grey-headed Flying-fox (*Pteropus poliocephalus*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Glossy Black Cockatoo (*Calyptorhynchus lathamii*), Powerful Owl (*Ninox strenua*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Green and Golden Bell Frog (*Litoria aurea*), Red-crowned Toadlet (*Pseudophryne australis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Eastern Bentwing-Bat (*Miniopterus schreibersii oceanensis*), Large-footed Myotis (*Myotis adversus*), Large-eared Pied Bat (*Chalinolobus dwyeri*).

Based on assessments of significance (including EPBC Matters of National Environmental Significance) conducted for the species listed above, the project is not considered to have a significant adverse affect on these threatened species.

The ten hectares of native vegetation required to be removed is chiefly found within the Hinterland Sandstone Gully Forest vegetation community that occurs throughout the M2 corridor. This vegetation community is not listed as an EEC under the EPBC Act or TSC Act and is widespread in the vicinity of the proposed M2 Upgrade project.

Approval under the EPBC Act is required where the DEWHA determines that there would likely be a significant impact on a matter of NES. A referral has been submitted to DEWHA for their determination. The referral illustrates that there are no significant impacts on matters of NES and therefore it recommends to DEWHA that the project is not a controlled action. On 19 February 2010 notification was received from DEWHA of the decision on referral (refer to Appendix G) concluding that the proposed action is not deemed a controlled action and does not require further assessment or approval under the EPBC Act.

The amount of vegetation estimated to be cleared is approximately 21 hectares in total. Of the ten hectares of native vegetation removed by the proposal, approximately three hectares would be subsequently rehabilitated. Whilst removal of vegetation within the development footprint would be permanent, clearing for access and compound areas would be temporary as these areas would be rehabilitated post-construction. The final construction methodology for access and compound sites would be determined during the detailed design phase. As the widening of the M2 Motorway is alongside the existing M2 Motorway, vegetation fragmentation is not likely to be significantly increased.

Some of the areas affected by the upgrade (primarily areas near waterways) are currently infested with exotic vines and scramblers. Earthworks have the potential to spread these species. The proposed mitigation measures have been designed to minimise the likelihood of the introduction, spread and proliferation of weeds and to encourage the regeneration of native vegetation.

The presence of impervious surfaces such as roads within the catchments of the study area has resulted in alteration of the flow regime of creeks adjacent to the M2 Motorway. Detention basin works proposed are being designed with capacity for the additional stormwater (refer to Section 10.1) from the M2 Motorway, therefore the increased road surface as a result of the works is not considered likely to further alter the hydrology of the creeks of the study area.

9.5.4 Mitigation measures

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

- Avoiding impacts.
- Minimising impacts.
- Mitigating impacts.

The planning and route selection processes have, as far as possible, avoided impacts on flora and fauna habitats. The following section details the measures that would be implemented to minimise and mitigate flora and fauna impacts.

An Environmental Management Plan (EMP) would be developed that describes in detail how each of the management measures prescribed would be implemented during construction (CEMP) and operation (OEMP) of the works. This plan would be developed in consultation with DECCW, Industry and Investment (I&INSW) and other relevant stakeholders. The CEMP would be produced in accordance with the Construction Environmental Management Framework (refer to Appendix F).

The CEMP would include measures to minimise removal of vegetation in areas of construction throughout the extent and duration of the project, such as:

- Clearly marking and delineating the extents of required vegetation clearance in order to minimise the risk of over-clearing.
- Minimising clearing for construction compounds by retaining mature trees and other vegetation of conservation significance where feasible within compound sites.
- The demarcation of Blue Gum High Forest boundary to avoid potential indirect impacts to this CEEC.
- Prior to the commencement of construction, specimens of *Epacris purpurascens var. purpurascens* within areas identified for temporary clearing would be marked by an ecologist. Wherever feasible, the temporary clearing extents would be slightly modified to avoid the need to remove individuals of this species. Pre-clearance surveys prior to construction would also be conducted by a suitably qualified ecologist to avoid the need to remove other threatened flora species potentially occurring within the M2 corridor, as listed in Table 81.
- Potential hollow-bearing trees would be identified and marked, and targeted measures to minimise potential harm to fauna during clearing would be implemented.
- Stabilisation of the riparian zone against flow changes would be implemented as described in Technical Paper 6, *M2 Upgrade Environmental Assessment – Surface Water Assessment* (AECOM 2010). Riparian areas disturbed during the works would be reinstated and replanted as quickly as possible.

The CEMP would include measures to minimise the indirect impacts on flora and fauna as a result of vegetation removal in areas of construction throughout the extent and duration of the project, such as:

- Earth-working machinery would be received on-site free from excessive soil and vegetative matter to minimise the likelihood of introducing weed seeds and plant pathogens (for example *Phytophthora* root rot fungus) to project areas.
- Cleaning of equipment used for works within detention basins to minimise the likelihood of the transmission of any frog pathogens (for example Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*)) would involve the use of a high pressure hose (or a suitable alternative method) to remove mud after use in a water body and allowing equipment to dry fully prior to use in the next water body.

Measures to minimise the direct impacts on flora and fauna would include:

- Prior to works which involve the clearing of vegetation and debris within detention basins and drainage lines, a suitable and targeted survey would be undertaken by an ecologist in order to allow for the detection of any Green and Golden Bell Frogs or Red-crowned Toadlets. If Green and Golden Bell Frogs or Red-crowned Toadlets are detected, no clearing works within these areas would commence until the threatened frog species response provisions in the EMP have been implemented.
- Weed control measures in known Red-crowned Toadlet occupation sites (TIDC site) should be avoided.
- Construction compound lighting would be directed towards the ground so that the angle between the beam and the vertical is kept as small as possible. Glare would be kept to a minimum by keeping the main beam angle less than 70 degrees wherever practicable.
- Non-translucent barriers should be positioned to shield sensitive locations located directly opposite access points to minimise disturbances to native fauna from vehicle headlights entering and exiting the site.
- Where feasible, site lighting should be directed away from sensitive locations such as potential foraging areas and movement corridors within the larger more intact areas of bushland such as Bidjigal Reserve, Lane Cove National Park and Pennant Hills Park. Wherever possible, trees would not be directly illuminated.
- Accessories such as light shields mounted at the front or back of the light source would be used where required to direct light to the intended area only and minimise excessive light spill.
- Where feasible, the mounting height of the lighting column would be lowered to reduce horizontal light spill.
- The use of high power lamps used for security at compound sites would be avoided where possible. Accessories such as glass protectors (glass glazing, preferred due to their UV filtration characteristics) would be considered during the design of light installations.

Measures to mitigate the loss of vegetation as a result of the project would include:

- Revegetation of disturbed areas as a result of construction activities, adjacent to the construction areas and bordering natural bushland, including fauna habitat removed for construction compounds, would be conducted by suitably qualified and experienced persons using local provenance plant species representative of the relevant vegetation communities. This strategy would be documented in a Landscape Plan or bushland rehabilitation section of the CEMP.
- In areas bordering adjacent urban development, revegetation works would be undertaken in accordance with a Landscape Plan.
- Where available, seeds would be collected from local understorey and ground layer vegetation prior to clearing and from felled trees and branches following clearing where feasible for use in revegetation.
- A revegetation strategy would be developed that takes into account the availability of light, moisture and the most suitable plant species.
- Reuse of felled native trees in habitat augmentation within revegetated areas and mulching of other native vegetation cleared for use in soil stabilisation and vegetation rehabilitation.
- Weed management as required in areas affected by construction throughout the extent and duration of the project (in a staged manner and for a minimum period of two year minimum following construction works).
- Reuse of the soil seedbank where practicable during revegetation works either within or outside the M2 corridor.

The CEMP would include measures to minimise the impacts on riparian vegetation and aquatic environments such as:

- Potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) would be stored in appropriate containers within bunded areas within construction compounds to minimise the risk of pollution of aquatic environments.
- Works around waterways would be managed to retain bank stability and prevent erosion.
- Water quality would be protected through the implementation of suitable sediment control measures in relevant work areas.
- Where practicable and feasible, bridge piers or foundations located within the main waterway channel would be avoided.
- Where practical, culverts would be aligned with the downstream channel to minimise bank erosion.
- Works would be sited and carried out to avoid the clearing of riparian vegetation where practicable.
- Riparian areas disturbed during the works would be reinstated and replanted as quickly as possible with the aim of providing a net long term biodiversity benefit.
- Where practicable and feasible, temporary piers would be used to maintain flow throughout the construction phase.

Biodiversity offset strategy

Although the ecological assessment concludes that the project would not have a significant impact on threatened flora and fauna species or ecological communities, there would be some residual impacts in relation to the clearing of vegetation. In order to offset the residual impacts to native fauna habitat and the residual impacts to *Epacris purpurascens* var. *purpurascens*, a biodiversity offset strategy would be developed in consultation with DECCW.

Of the approximately ten hectares of native vegetation proposed to be cleared by the project, approximately three hectares would be subsequently rehabilitated. The residual impacts of the project comprise the permanent clearing of some seven hectares of native vegetation. The offset strategy prepared for the project would aim to address the loss of this vegetation, consisting of the following vegetation types:

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

The offset strategy would focus on conservation and enhancement of habitat in the M2 corridor.

The biodiversity offset strategy would outline the process for identifying priority areas for habitat enhancement within the M2 corridor and measures that would be undertaken to enhance the value of habitat. The areas to be included in the biodiversity offset strategy and the specific measures to be implemented would be determined in consultation with DECCW.

In terms of identifying priority areas for habitat enhancement, it is anticipated that priority would be given to habitat within the M2 corridor that adjoins major waterway crossings, is along the edges of high quality native vegetation in which weed invasion is apparent and the edges of waterways. In addition, factors such as the condition of habitat, its connectivity and proximity to remnant native vegetation would also be considered when identifying areas for enhancement.

Management measures to enhance native fauna habitat within the M2 corridor would include bush regeneration throughout the M2 corridor, installation of nest boxes for birds and bats, and the use of

boulders and felled timber to enhance the structural complexity of fauna habitat. The following management actions would also be considered:

- Control of weeds.
- Management of fire for conservation.
- Management of human disturbance.
- Retention of regrowth and remnant native vegetation.
- Replanting or supplementary planting where natural regeneration would not be sufficient.
- Retention of dead timber.
- Control of erosion.
- Retention of rocks.