Transport for NSW

Chapter 16
Biodiversity

NSW GOVERNMENT

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16 Biodiversity

This chapter provides a summary of the biodiversity assessment. It describes existing biodiversity, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Paper 9 (Biodiversity Development Assessment Report).

16.1 Approach

The biodiversity assessment has been undertaken in accordance with the *Biodiversity Assessment Method* (DPIE, 2020b), as the key guidance to assessing and managing potential impacts on biodiversity in NSW. The biodiversity assessment has also been undertaken in accordance with:

- the SEARs (see Appendix A (SEARs compliance table))
- applicable legislation (including the EP&A Act, the *Biodiversity Conservation Act 2016* (NSW) (the BC Act) and the Biodiversity Conservation Regulation 2017 (the BC Regulation), the *Fisheries Management Act 1994* (NSW) (the FM Act), the *Biosecurity Act 2015* (NSW) and the EPBC Act
- other relevant policies and guidelines, including guidelines for surveying threatened species and guidelines for assessing the potential significance of impacts on matters of national environmental significance under the EPBC Act.

A detailed description of the legislative and policy context for the assessment is provided in section 2 of Technical Paper 9 (Biodiversity Development Assessment Report). An overview of the approach to the assessment is provided below. Further information on the assessment methodology is provided in section 3 of Technical Paper 9.

16.1.1 Study area

The study area for the biodiversity assessment includes the area with the potential to be directly affected during construction (the project site as described in Chapter 2 (Location and setting)) and adjoining areas with the potential to be indirectly affected.

A buffer of 500 metres around the project site was used for background research, including database searches.

16.1.2 Key tasks

The assessment involved:

- background research, including reviewing previous assessments relevant to the study area and database searches, to confirm the:
  - likely distribution of native vegetation and threatened ecological communities listed under the BC Act, FM Act and/or the EPBC Act
  - likely presence of threatened flora and fauna listed under the BC Act and/or the FM Act and matters of national environmental significance listed under the EPBC Act

  - potential presence of groundwater dependent ecosystems
  - presence of key fish habitat and coastal wetlands
- assessing the potential for *Biodiversity Assessment Method* species credit species to occur in the project site and be impacted by the project
- terrestrial flora and fauna field surveys across a range of seasons to map vegetation, describe habitats, and confirm whether listed threatened flora and fauna species or communities are present
- assessing the potential impacts on native vegetation and habitats, threatened species, groundwater dependent ecosystems, key threatening processes and matters of national environmental significance
- identifying measures to mitigate and offset the impacts identified, including a biodiversity offset strategy
- preparing a Biodiversity Development Assessment Report to describe the results of the assessment in accordance with section 6.12 of the BC Act, clause 6.8 of the BC Regulation and the *Biodiversity Assessment Method*.

Potential impacts on amenity trees are considered in Chapter 15 (Landscape and visual amenity).

16.1.3 How potential impacts have been avoided or minimised

The approach to design development included a focus on avoiding and/or minimising the potential for impacts during key phases of the design process. As described in Chapter 5 (Design development, alternatives and options) a project corridor and alignment options assessment process was undertaken to identify the preferred alignment. This process considered a range of factors, including biodiversity values and possible offset obligations.

The design has been refined to avoid impacts on biodiversity values (including native vegetation and habitats) where possible, including:

- maximising use of existing transport corridors (including road reserves) and disturbed areas with no or limited native vegetation
- avoiding direct impacts on remnant native vegetation (forest and wetland habitat) in Newington Nature Reserve
- locating the proposed bridges over the Parramatta River to make use of natural gaps in mangrove vegetation
- proposing a balanced cantilever concrete box girder bridge type (with fewer piers than other bridge types) and the use of elevated temporary jetties to construct the bridges to minimise direct impacts on mangrove vegetation
- siting temporary compounds away from sensitive sites to avoid impacts on constructed frog habitat within Sydney Olympic Park.

16.2 Existing environment

16.2.1 Landscape biodiversity features

Landscape features contribute to the overall biodiversity value of the study area and are used to inform the appropriateness of biodiversity offsets. The key landscape features, as defined by the *Biodiversity Assessment Method*, and how these relate to the study area, are summarised in Table 16.1.

Table 16.1 Landscape features within the project site

Landscape feature	Project site
Interim Biographic Regionalisation for Australia bioregion and subregion	The project site is located within the Sydney Basin Bioregion and the Cumberland subregion.
NSW landscape regions (Mitchell landscapes)	The project site is located within the Port Jackson Basin, Pennant Hills Ridges and Ashfield Plains landscape regions.
Rivers and streams	The project site crosses the Parramatta River and Haslams Creek. The Parramatta River is the main tributary of the Sydney Harbour catchment.
Important and local wetlands on, adjacent and downstream of the project site	The Directory of Important Wetlands in Australia does not list any important wetlands on, adjacent or downstream of the project site. The wetlands at Newington Nature Reserve, and Narawang Wetland in the Millennium Parklands are located adjacent to the project site.
Habitat connectivity features	The main habitat corridors within the project site are associated with the Parramatta River, Haslams Creek and their associated riparian zones. Habitat connectivity is provided in native and planted vegetation in Newington Nature Reserve and areas of the Millennium Parklands at Sydney Olympic Park. Constructed channels and culverts within the Millennium Parklands (including under Hill Road) also provide habitat connectivity for the Green and Golden Bell Frog.
Areas of geological significance and soil hazard features	There are no areas of geological significance within the project site. There is a high probability of acid sulfate soils within the project site (see Chapter 18 (Soils and contamination).
Areas of outstanding biodiversity value under the BC Act	There are no areas of outstanding biodiversity values within the project site.

16.2.2 Terrestrial flora

Vegetation communities

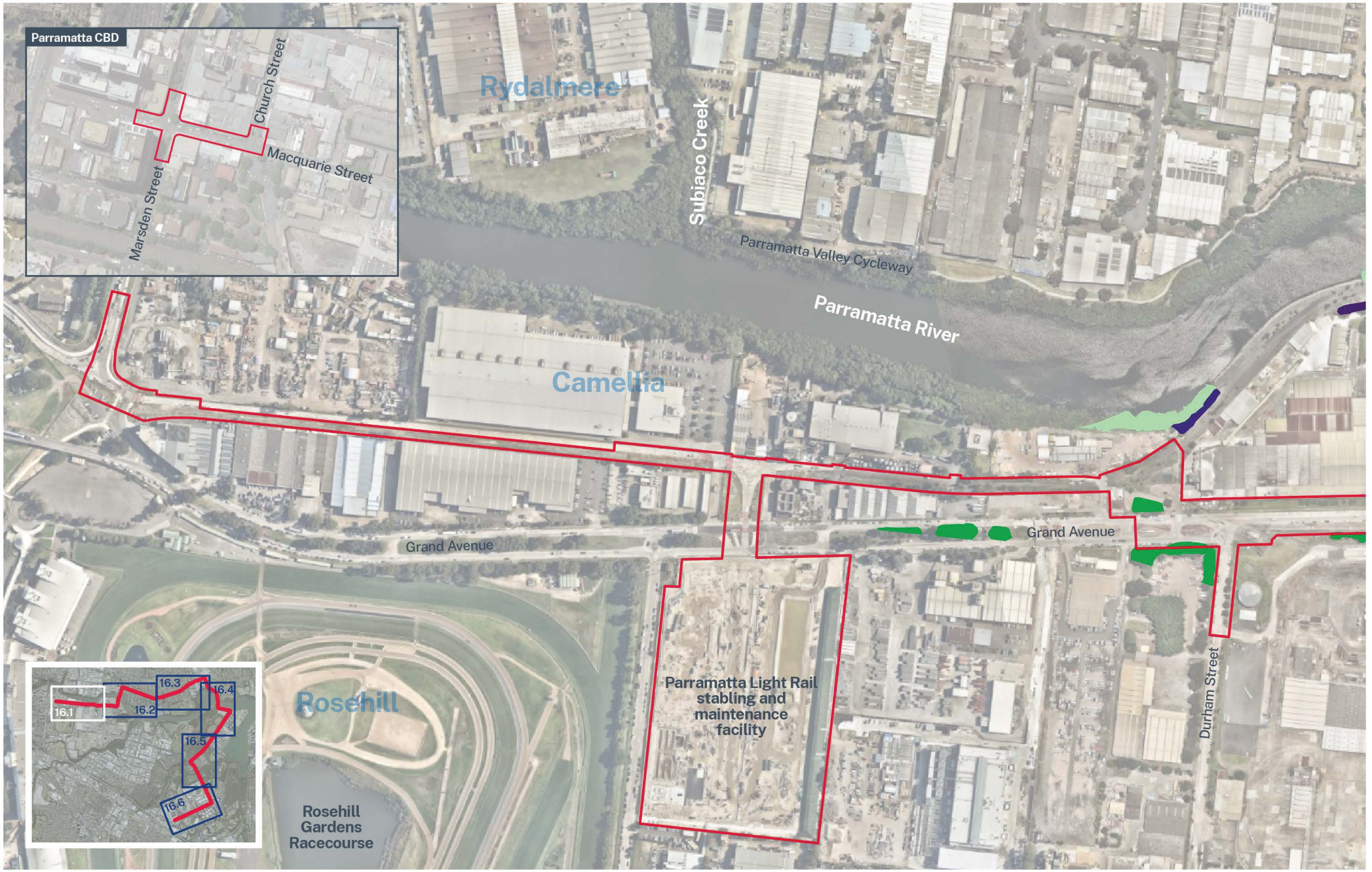
The project site contains large areas of cleared and modified land that support urban plantings, as well as some smaller areas of native vegetation. Native vegetation is predominantly associated with riparian zones and Newington Nature Reserve, as well as some small areas in Sydney Olympic Park (in the Millennium Parklands).

Plant community types (PCTs) within the project site are summarised in Table 16.2 and shown in Figure 16.1 to Figure 16.6. Only a small proportion of the vegetation in the project site comprises native vegetation (about 2.55 hectares in total).

Table 16.2 Plant community types within the project site

Plant community type (PCT) name	PCT ref	Conservation status	Condition	Total area in project site (hectares)
Native vegetation				
Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	PCT 920	Protected marine vegetation under the FM Act	Good	0.91
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	PCT 1071	Endangered ecological community under the BC Act	Moderate	0.07
Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	PCT 1126	Protected marine vegetation under the FM Act Endangered ecological community under the BC Act Vulnerable ecological community under the EPBC Act	Moderate	0.05

Plant community type (PCT) name	PCT ref	Conservation status	Condition	Total area in project site (hectares)
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	PCT 1234	Endangered ecological community under the BC Act No patches in the project site meet the condition criteria for the endangered ecological community listed under the EPBC Act	Moderate Poor Planted	0.01 0.20 0.26
Turpentine – Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion	PCT 1281	Critically endangered ecological community under the BC Act No patches in the project site meet the condition criteria for the endangered ecological community listed under the EPBC Act	Planted	1.05
Total native vegetation in project site				***2.55***
Disturbed areas and non-native vegetation				
Non-native vegetation (planted vegetation)	n/a	Not applicable	Poor to moderate	5.79
Highly disturbed areas with no or limited native vegetation (including cleared land and infrastructure)	n/a	Not applicable	Not applicable	56.14
Total disturbed areas and non-native vegetation in project site				***61.93***
Total vegetation (including disturbed areas)				**64.48**



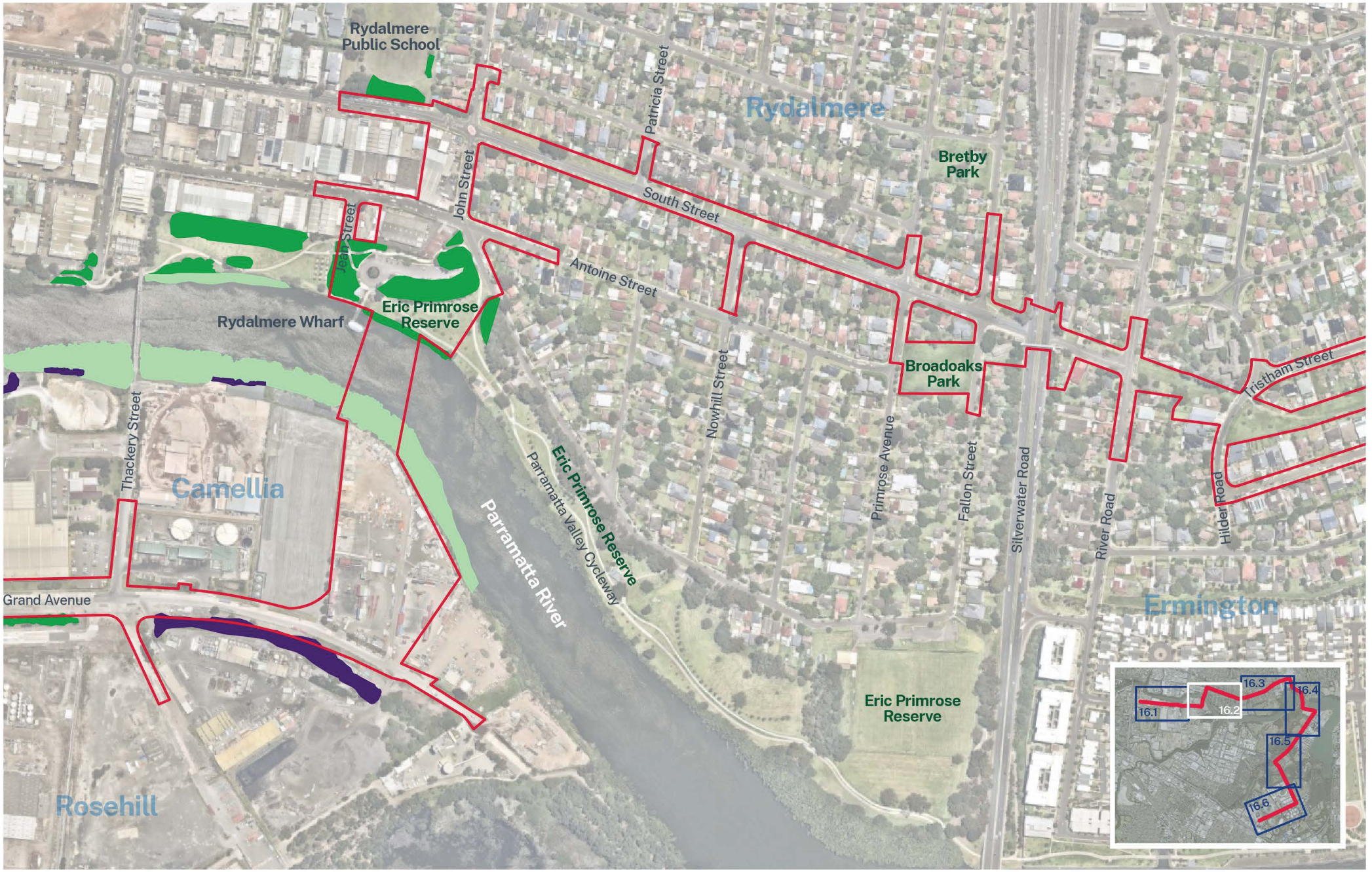
LEGEND

- Project site
- Planted vegetation
- Estuarine Swamp Oak forest (PCT 1234) Poor condition
- Estuarine mangrove forest (PCT 920) Good condition

Figure 16.1 Vegetation communities - map 1

0 300m

N



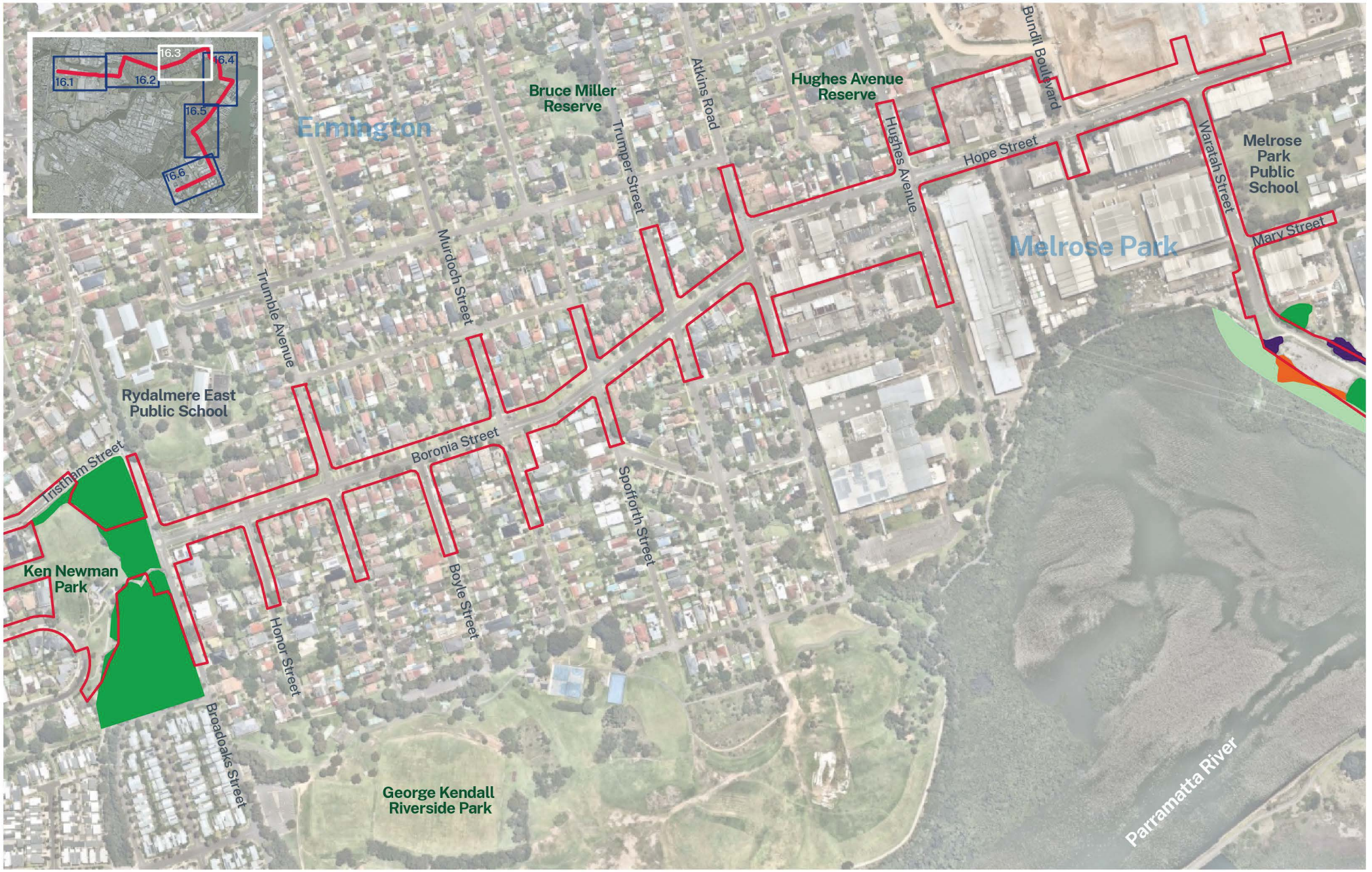
LEGEND

- Project site
- Planted vegetation
- Estuarine Swamp Oak forest (PCT 1234) Poor condition
- Estuarine mangrove forest (PCT 920) Good condition

Figure 16.2 Vegetation communities - map 2

0 300m

N



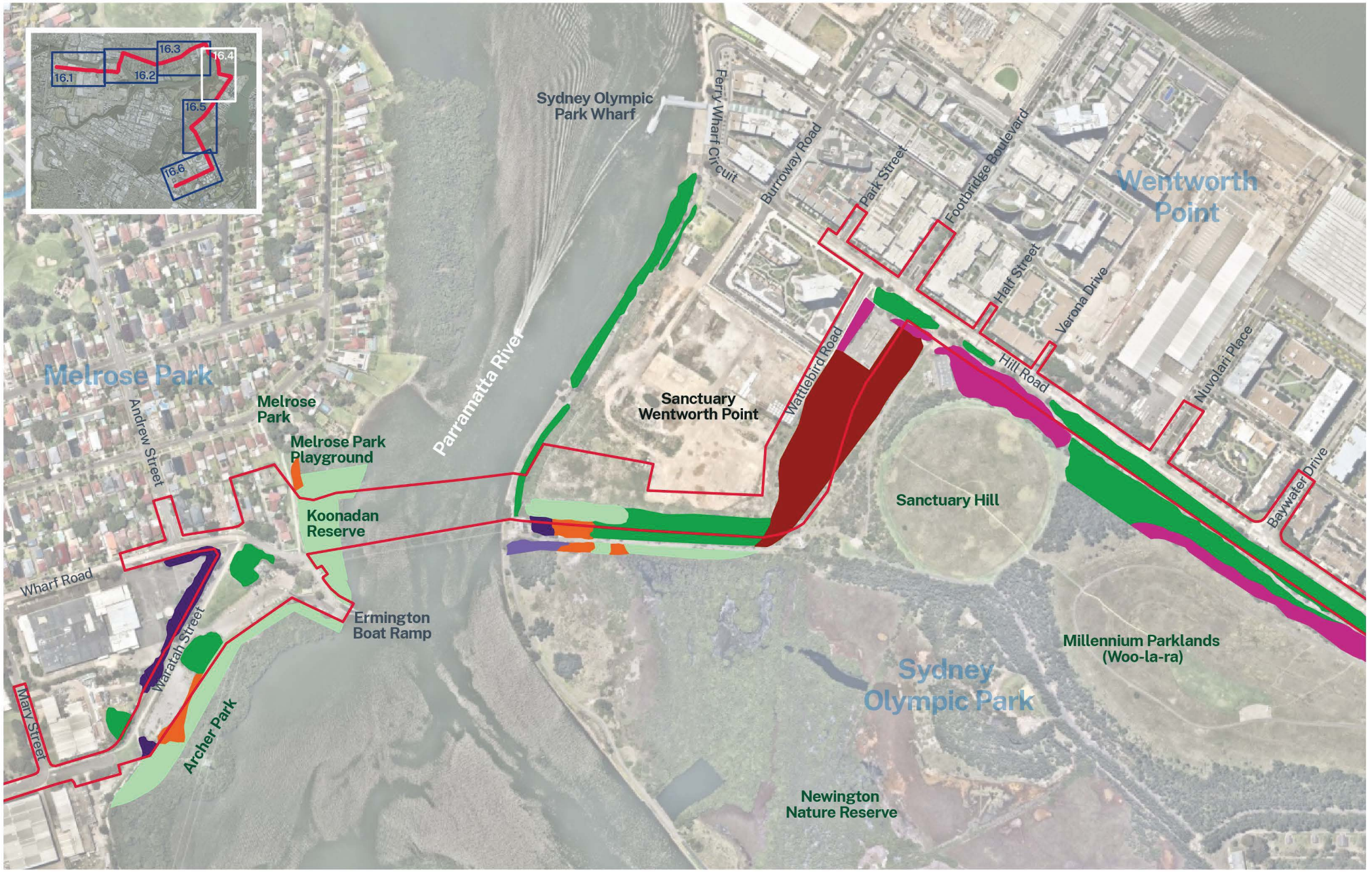
LEGEND

- Project site
- Planted vegetation
- Estuarine Swamp Oak forest (PCT 1234) Poor condition
- Estuarine mangrove forest (PCT 920) Good condition
- Estuarine saltmash (PCT 1126) Moderate condition

Figure 16.3 Vegetation communities - map 3

0 300m

N

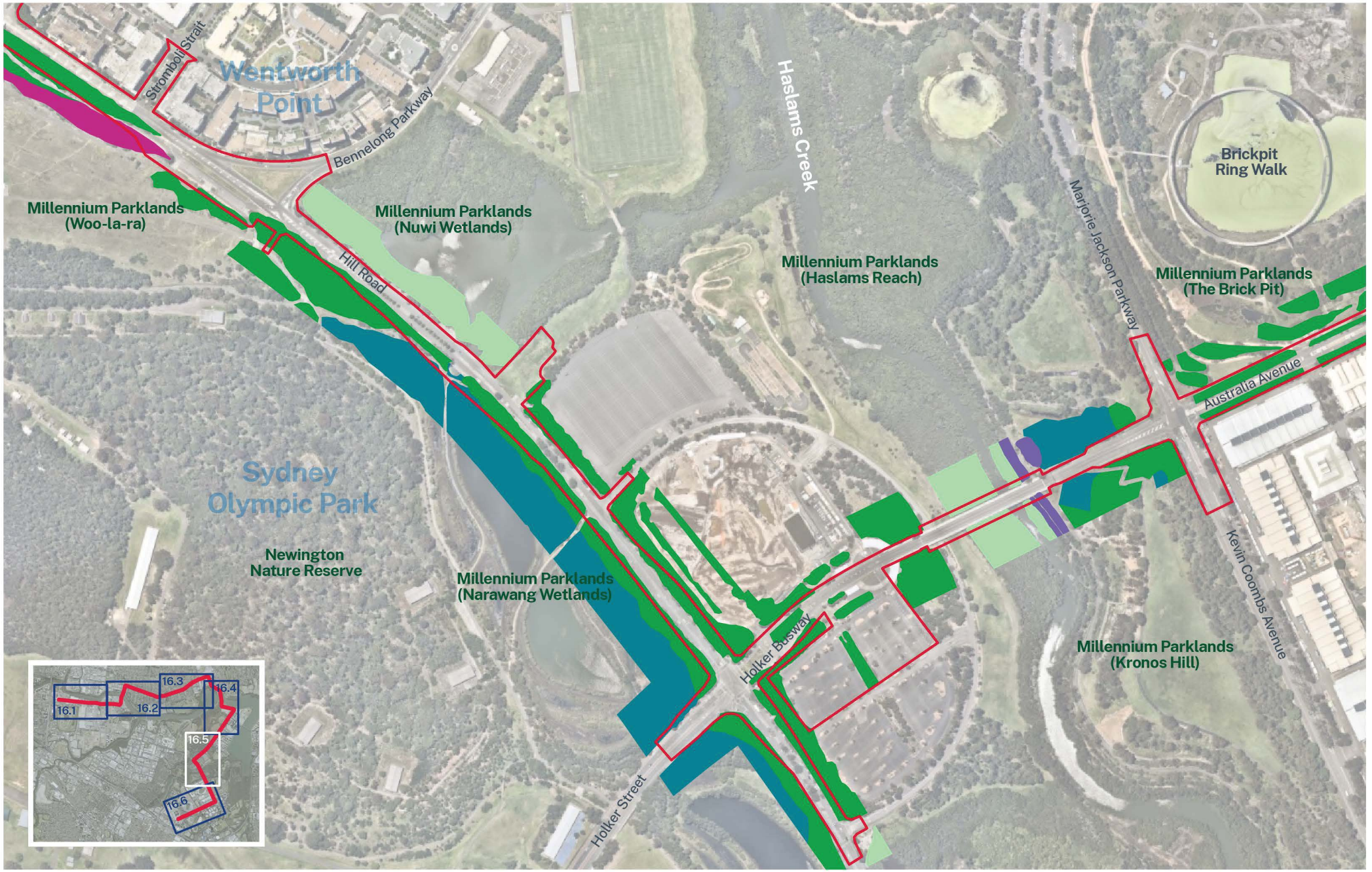


LEGEND

- Project site
- Planted vegetation
- Estuarine mangrove forest (PCT 920) Good condition
- Turpentine – Grey Ironbark open forest (PCT 1281) Planted condition
- Estuarine saltmash (PCT 1126) Moderate condition
- Estuarine Swamp Oak forest (PCT 1234) Planted condition
- Estuarine Swamp Oak forest (PCT 1234) Moderate condition
- Estuarine Swamp Oak forest (PCT 1234) Poor condition

Figure 16.4 Vegetation communities - map 4

0 300m



LEGEND

- Project site
- Planted vegetation
- Estuarine mangrove forest (PCT 920) Good condition
- Estuarine Swamp Oak forest (PCT 1234) Planted condition
- Estuarine Swamp Oak forest (PCT 1234) Moderate condition
- Coastal freshwater wetlands (PCT 1071) Moderate condition

Figure 16.5 Vegetation communities - map 5

0 300m

LEGEND

- Project site
- Planted vegetation

Figure 16.6 Vegetation communities - map 6

0 300m

Native vegetation in the project site

The *Biodiversity Assessment Method* requires the extent of native vegetation within a 'project area' (defined in the EIS, and referred to in this chapter, as the project site) to be mapped. Native vegetation in the project site has been classified into PCTs, as shown on Figure 16.1 to Figure 16.6, and summarised in Table 16.2. The native PCTs in the project site are described below.

Estuarine mangrove forest (PCT 920)

Estuarine mangrove forest vegetation occurs along the riparian corridors, in areas subject to tidal inundation. In the project site it is dominated by Grey Mangrove (*Avicennia marina* subsp. *Australasica*) open forest on mudflat with occasional exotic groundcover species. Some hollow-bearing trees were observed within patches of this community during field surveys. The hollows observed were suitable for microbats and small fauna. There were no hollows large enough to be suitable for owls and cockatoos.

Figure 16.7 shows a representative patch of estuarine mangrove forest, located on the banks of the Parramatta River at Melrose Park.

Figure 16.7 Representative patch of estuarine mangrove forest

Phragmites australis and *Typha orientalis* coastal freshwater wetland (PCT 1071)

The *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands have been created via landform modification and revegetation works, and now function as a naturally occurring ecosystem containing native grass and rush species. This plant community occurs in Narawang Wetland (in the Millennium Parklands) in the south-eastern section of the study area in Sydney Olympic Park, which were created to provide habitat for the Green and Golden Bell Frog.

Figure 16.8 shows a representative patch of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands near the Holker Busway bridge in Sydney Olympic Park.

Figure 16.8 Representative patch of *Phragmites australis* and *Typha orientalis* coastal freshwater wetland

Estuarine saltmarsh (PCT 1126)

Estuarine saltmarsh vegetation occurs on the landward side of stands of mangroves along estuaries, in areas subject to tidal flows. The saltmarsh vegetation is dominated by understorey of low succulent forbs and rushes and has an occasional overstorey of Grey Mangrove (*Avicennia marina* subsp. *Australasica*) and Swamp Oak (*Casuarina glauca*). Narrow-leafed Wilsonia (*Wilsonia backhousei*) is typically found on the edges of estuarine saltmarshes. A population of the Narrow-leafed Wilsonia (*Wilsonia backhousei*) is located adjacent to the project site within the Newington Nature Reserve Wetland.

Figure 16.9 shows a representative patch of estuarine saltmarsh near the Parramatta River at Melrose Park.

Figure 16.9 Representative patch of estuarine saltmarsh

Estuarine Swamp Oak Forest (PCT 1234)

The estuarine Swamp Oak Forest vegetation is generally located on land with limited tidal influence, adjacent to mangrove and saltmarsh vegetation. It was generally identified on the landward side of mangrove and saltmarsh communities within the project site. It is an open forest with an overstorey of Swamp Oak (*Casuarina glauca*), and a midstorey and understorey dominated by exotic species.

Some occurrences of Swamp Oak Forest were identified on artificial soil profiles along roadsides where it has been planted as part of landscaping works.

Figure 16.10 shows a representative patch of estuarine Swamp Oak Forest near the Parramatta River (in the suburb of Sydney Olympic Park on the Wentworth Point peninsula).

Figure 16.10 Representative patch of estuarine Swamp Oak Forest

Sydney Turpentine-Ironbark Forest (PCT 1281)

Remnant Sydney Turpentine-Ironbark Forest vegetation was identified adjacent to the project site within Newington Nature Reserve. Areas of this vegetation (including within the project site) were planted in the Millennium Parklands to replicate the remnant Sydney Turpentine-Ironbark Forest within Newington Nature Reserve. Planted Sydney Turpentine-Ironbark Forest comprises an open forest with a sparse, disturbed midstorey and understorey located on a modified landscape subject to land forming works.

Figure 16.11 shows a representative patch of Sydney Turpentine-Ironbark Forest in the Millennium Parklands at Sydney Olympic Park.

Figure 16.11 Representative patch of planted Sydney Turpentine-Ironbark Forest

Threatened ecological communities

Four PCTs in the project site conform to four threatened ecological communities listed under the BC Act and one that is also listed under the EPBC Act. These communities are listed in Table 16.3 with the corresponding PCT identification number. The conservation status of the communities is provided in Table 16.2.

Table 16.3 Summary of threatened ecological communities in the project site

PCT ID (see Table 16.2)	BC Act listing	EPBC Act listing
1071	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	None
1126	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Subtropical and Temperate Coastal Saltmarsh (Coastal Saltmarsh)
1234	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	None
1281	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion	Planted vegetation, which does not meet condition criteria of the listed community

Flora species

The field survey identified a total of 166 flora species in the project site. These comprised 101 native and 65 exotic species. A full list of the species identified is provided in Appendix C of Technical Paper 9 (Biodiversity Development Assessment Report).

Threatened flora

The results of the database searches indicated that 60 threatened flora species or populations listed under the BC Act, and 44 threatened flora species listed under the EPBC Act, have been recorded or are predicted to occur in the study area. Of these, six species were identified as candidate species credit species that required survey in accordance with the *Biodiversity Assessment Method*.

One naturally occurring threatened flora species was recorded during surveys in the northern section of the Newington Nature Reserve – the Narrow-leafed Wilsonia (*Wilsonia backhousei*), which is a shrub listed as a vulnerable species under the BC Act.

Weeds

Weeds are common throughout the study area and include environmental weeds and weeds with formal control measures identified. The Biosecurity Act identifies priority weeds in NSW that have been assigned a biosecurity duty (such as prohibitions on sale and control measures). Five species within the project site are listed by the Biosecurity Act as priority weeds for the Greater Sydney region. Three of these species are also listed as Weeds of National Significance – Blackberry (*Rubus fruticosus* spp. aggregate), Bridal Creeper (*Asparagus asparagoides*) and Lantana (*Lantana camara*).

Groundwater dependent ecosystems

Groundwater dependent ecosystems rely on a supply of groundwater to support the species composition, structure and function of the ecosystem. Patches of vegetation along the Parramatta River, comprising areas of mangroves, are mapped as 'high potential groundwater dependent ecosystems' by the *Groundwater Dependent Ecosystem Atlas* (Bureau of Meteorology, 2021a). There are no aquatic or subterranean groundwater dependent ecosystems mapped in the study area.

16.2.3 Terrestrial fauna

Terrestrial fauna habitats

Terrestrial fauna habitat values are associated with native and planted vegetation within the study area. General fauna habitats include:

- mangroves and saltmarsh
- Swamp Oak Forest
- Sydney Turpentine-Ironbark Forest
- planted trees
- exotic grassland
- wetlands
- human-made features, including bridges and culverts.

A full description of the habitat type and predicted threatened fauna species recorded or likely to occur in each is provided in section 5 of Technical Paper 9 (Biodiversity Development Assessment Report).

In general, vegetation in the study area is highly fragmented by the existing network of roads and development. There are few large tracts of native vegetation outside of the Newington Nature Reserve, and all areas are subject to ongoing disturbance from surrounding land uses.

Fauna

A total of 76 fauna species were recorded during field surveys. These included 64 bird species, five mammal species, five frog species, and two reptile species. A full list of recorded species is provided in Appendix D of Technical Paper 9 (Biodiversity Development Assessment Report).

Threatened fauna

The results of the database searches indicated that 62 threatened fauna species or populations listed under the BC Act, and 24 threatened fauna species listed under the EPBC Act, have been recorded or are predicted to occur in the study area. Of these, 20 species were identified as 'candidate' species credit entities that required survey in accordance with the *Biodiversity Assessment Method*. During the field surveys, four threatened fauna species listed as endangered or vulnerable under the BC Act were recorded within the project site (see Table 16.4).

Additionally, four fauna species listed under the BC Act or EPBC Act were assumed to be present based on previous records and suitable potential habitat. These species have also been nominated as species credit entities (see Table 16.4). A summary of these confirmed threatened species, and justification for the exclusion of other candidate species, is provided in section 6.3 of Technical Paper 9 (Biodiversity Development Assessment Report).

Table 16.4 Threatened fauna species recorded during field surveys or assumed to be present

Common name	Scientific name	BC Act listing	EPBC Act listing	Where recorded
Recorded during survey				
Grey-headed Flying-fox	*Pteropus poliocephalus*	Vulnerable	Vulnerable	Recorded foraging at various locations in the study area
Southern Myotis	*Myotis macropus*	Vulnerable	-	Breeding colony present at Sydney Olympic Park
White-bellied Sea-eagle	*Haliaeetus leucogaster*	Vulnerable	-	Recorded foraging in the Parramatta River and known to nest at Newington Nature Reserve
Powerful Owl	*Ninox strenua*	Vulnerable	-	Heard calling near Ken Newman Park
Presence assumed and species credits calculated				
Green and Golden Bell Frog	*Litoria aurea*	Endangered	Vulnerable	Key population present at Sydney Olympic Park and Newington Nature Reserve However, there was no evidence of this species during targeted surveys in Camellia
Bar-tailed Godwit	*Limosa lapponica*	-	Vulnerable	Project site intersects mapped important habitat
Black-tailed Godwit	*Limosa limosa*	Vulnerable	-	Occasional records in Homebush Bay, Bird Hide and Newington Nature Reserve
Curlew Sandpiper	*Calidris ferruginea*	Endangered	Critically endangered	Project site intersects mapped important habitat

16.2.4 Aquatic biodiversity

Aquatic habitats

Key aquatic habitats identified within the project site comprise the Parramatta River, Haslams Creek and Narawang Wetland.

Parramatta River

The Parramatta River is a large, tidal estuary. Much of the river is vegetated with mangroves. Artificial rock seawalls are present at some locations at Wentworth Point and Camellia (see Figure 16.12). Open mudflats are located in the Melrose Park area, east of the project site.

The Parramatta River is mapped as key fish habitat. It is classified as Type 1 (key fish habitat) and is also classified as Class 1 (major key fish habitat) as it is a permanently flowing river.

Figure 16.12 Parramatta River at Camellia, showing rock walls and mangroves

Haslams Creek

Haslams Creek is a highly modified watercourse that drains into the Parramatta River at Homebush Bay. The catchment of Haslams Creek is highly urbanised with the upper extents generally concrete lined open channels and pipes. The creek is tidal and vegetated with mangroves through the study area (see Figure 16.13).

Haslams Creek is mapped as key fish habitat. It is classified as Type 1 (key fish habitat) and is also classified as Class 1 (major key fish habitat) as it is a permanently flowing watercourse.

Figure 16.13 Haslams Creek (view upstream from Holker Busway bridge)

Wetlands

Narawang Wetland was constructed on remediated land north of Haslams Creek (see Figure 16.14). The wetland contains 22 large clay-based habitat ponds, three irrigation storages and an ornamental lake, and was planted with native reeds, grasses, shrubs and trees. The constructed habitat simulates a freshwater wetland on coastal floodplain by receiving floodwaters from Haslams Creek and a floodway under Hill Road linked to Nuwi Wetland. Stormwater from a 105 hectare catchment, comprising areas in Newington, Parkland Junction and along Hill Road, also feeds into Narawang Wetland for water quality treatment, storage and subsequent irrigation re-use.

Newington Nature Reserve Wetland is a highly modified estuarine wetland system within the Newington Nature Reserve near the Parramatta River. The hydrology of the wetland is managed by constructed flushing channels, adjustable weirs, bunding, stormwater pipes and drains. It contains large areas of saltmarsh and mangroves. Despite its modified nature, Newington Nature Reserve Wetland is an intact and diverse estuarine wetland system containing significant areas of remnant saltmarsh and mangroves in excellent condition.

Figure 16.14 Narawang Wetland

Threatened aquatic species

No threatened fish or marine species listed under the FM Act, BC Act or EPBC Act are considered likely to occur within the Parramatta River or Haslams Creek. No suitable rocky reef habitat is present for the Black Rock Cod *(Epinephelus daemelii),* which is known to occur in the Sydney area, and can occur in estuarine environments.

16.2.5 Matters of national environmental significance

Threatened ecological communities

One threatened ecological community, Subtropical and Temperate Coastal Saltmarsh (Coastal Saltmarsh), which is listed as vulnerable under the EPBC Act, was identified in the project site (see section 16.2.2). This community was recorded at various locations, generally associated with the floodplains of the Parramatta River and Haslams Creek. Newington Nature Reserve contains the largest remaining stand of Coastal Saltmarsh on the Parramatta River.

Threatened flora and fauna species

One threatened fauna species, the Grey-headed Flying-fox, which is listed as vulnerable under the EPBC Act, was identified during surveys. Several other threatened species, while not identified during surveys, are known or may occur in the study area. These includes the Green and Golden Bell Frog (listed as vulnerable under the EPBC Act), with key populations present at Sydney Olympic Park, Newington Nature Reserve and Clyde/Rosehill (see Table 16.4).

No threatened flora species listed under the EPBC Act were identified in the project site.

Migratory species

Shorebirds

Habitat along the Parramatta River, Haslams Creek and Narawang Wetland was identified as important habitat for the Bar-tailed Godwit (*Limosa lapponica*) and Curlew Sandpiper (*Calidris ferruginea*).

Latham's Snipe are regularly observed at Sydney Olympic Park, including at Narawang Wetland, the Brickpit, Northern Water Feature and Newington Nature Reserve Wetland. Regular monitoring of the population is undertaken by Sydney Olympic Park Authority, with Narawang Wetland identified as the preferred habitat of the species. Due to proximity of the wetlands and observations of snipes moving between wetlands, Sydney Olympic Park and Newington Nature Reserve provide important habitat for Latham's Snipe.

Threatened species of migratory shorebirds that are known or may occur in the study area are summarised in Table 16.5.

Table 16.5 Migratory shorebird species that are known or may occur in the study area

Common name	Scientific name	EPBC Act status[1]	Recorded areas
Latham's Snipe	*Gallinago hardwickii*	M	Known to occur within Sydney Olympic Park.
Bar-tailed Godwit Curlew Sandpiper	*Limosa lapponica* *Calidris ferruginea*	V, M CE, M	Groups of these species are regularly recorded within saltmarsh areas within Newington Nature Reserve Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park, as well as the mudflats of the Parramatta River.
Common Greenshank Marsh Sandpiper Pacific Golden Plover Pectoral Sandpiper Red-necked Stint Sharp-tailed Sandpiper	*Tringa nebularia* *Tringa stagnatillis* *Pluvialis fulva* *Calidris melanotis* *Calidris ruficollis* *Calidris acuminata*	M	Records associated with saltmarsh areas within Newington Nature Reserve Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park.
Eastern Curlew Great Knot Broad-billed Sandpiper Double-banded Plover	*Numenius madagascariensis* *Calidris tenuirostris* *Limicola falcinellus* *Charadrius bicinctus*	CE, M CE, M M M	Occasional observations of individuals or small groups of these species at Newington Nature Reserve Wetland and the Waterbird Refuge.

Note 1: CE – critically endangered, E – endangered, M – migratory, V – vulnerable

Migratory terrestrial species

Six migratory terrestrial species that may occur in the project site are described in Table 16.6.

Table 16.6 Migratory (terrestrial) species that may occur in the study area

Common name	Scientific name	Likelihood of occurrence
Black-faced Monarch	*Monarcha melanopsis*	Individuals are observed on occasion in Newington Nature Reserve and Sydney Olympic Park.
Eastern Osprey	*Pandion haliaetus*	Few records in the area. May forage on occasion along the Parramatta River. No known breeding pairs in the locality.
Fork-tailed Swift	*Apus pacificus*	Would forage high above the project site on occasion.
Rufous Fantail	*Rhipidura rufifrons*	This species may forage and breed in the project site.
Satin Flycatcher	*Myiagra cyanoleuca*	Individuals are observed on occasion in Newington Nature Reserve and Sydney Olympic Park.
White-throated Needletail	*Hirundapus caudacutus*	May forage above the project site. May roost on occasion in the project site.

16.2.6 Protected and sensitive lands

The locations of protected and sensitive lands with respect to the project site are shown on Figure 16.15 and Figure 16.16 and summarised in Table 16.7.

Table 16.7 Summary of protected and sensitive lands within the study area

Protected areas and sensitive lands	Presence within the study area
Coastal wetlands	Coastal wetlands mapped by State Environmental Planning Policy (Resilience and Hazards) 2021 are located along the Parramatta River and Haslams Creek, and in Newington Nature Reserve. The project site crosses mapped coastal wetlands along the Parramatta River at Camellia, Rydalmere, Melrose Park, Wentworth Point and along Haslams Creek at Sydney Olympic Park.
High biodiversity value land	The project site crosses high biodiversity value land identified on the Biodiversity Values Map under the BC Act at the Parramatta River and Haslams Creek.
Protected areas	The Newington Nature Reserve, which is a protected area managed under the *National Parks and Wildlife Act 1974* (NSW), is located adjacent to the project site in the suburb of Sydney Olympic Park.
Key fish habitat	The Parramatta River and Haslams Creek are mapped as key fish habitat. The project site crosses the river (in two locations via the proposed bridges) and Haslams Creek (via the Holker Busway bridge).
Waterfront land	Waterfront land is defined under the *Water Management Act 2000* (NSW) as the bed of any river, lake or estuary, and the land within 40 metres of the riverbanks, lake shore or estuary mean high water mark. Parts of the study area near the Parramatta River are within waterfront land, at Camellia, Rydalmere, Melrose Park and Wentworth Point. The project site crosses waterfront land in these locations.
Critical habitat	No land or waters within the study area are identified as critical habitat under the FM Act or EPBC Act, or areas of outstanding biodiversity value under the BC Act.
Offset sites	No biodiversity stewardship sites or private conservation lands occur in the study area. Some of the precincts in the Millennium Parklands (including Narawang Wetland, Kronos Hill, Wentworth Common and the Brickpit) are zoned for environmental conservation. Narawang Wetland includes constructed habitats designed for the Green and Golden Bell Frog, which were developed in the 1990s to offset impacts associated with development within Sydney Olympic Park. A narrow strip of the project site intersects with the edge of Narawang Wetland along Hill Road.

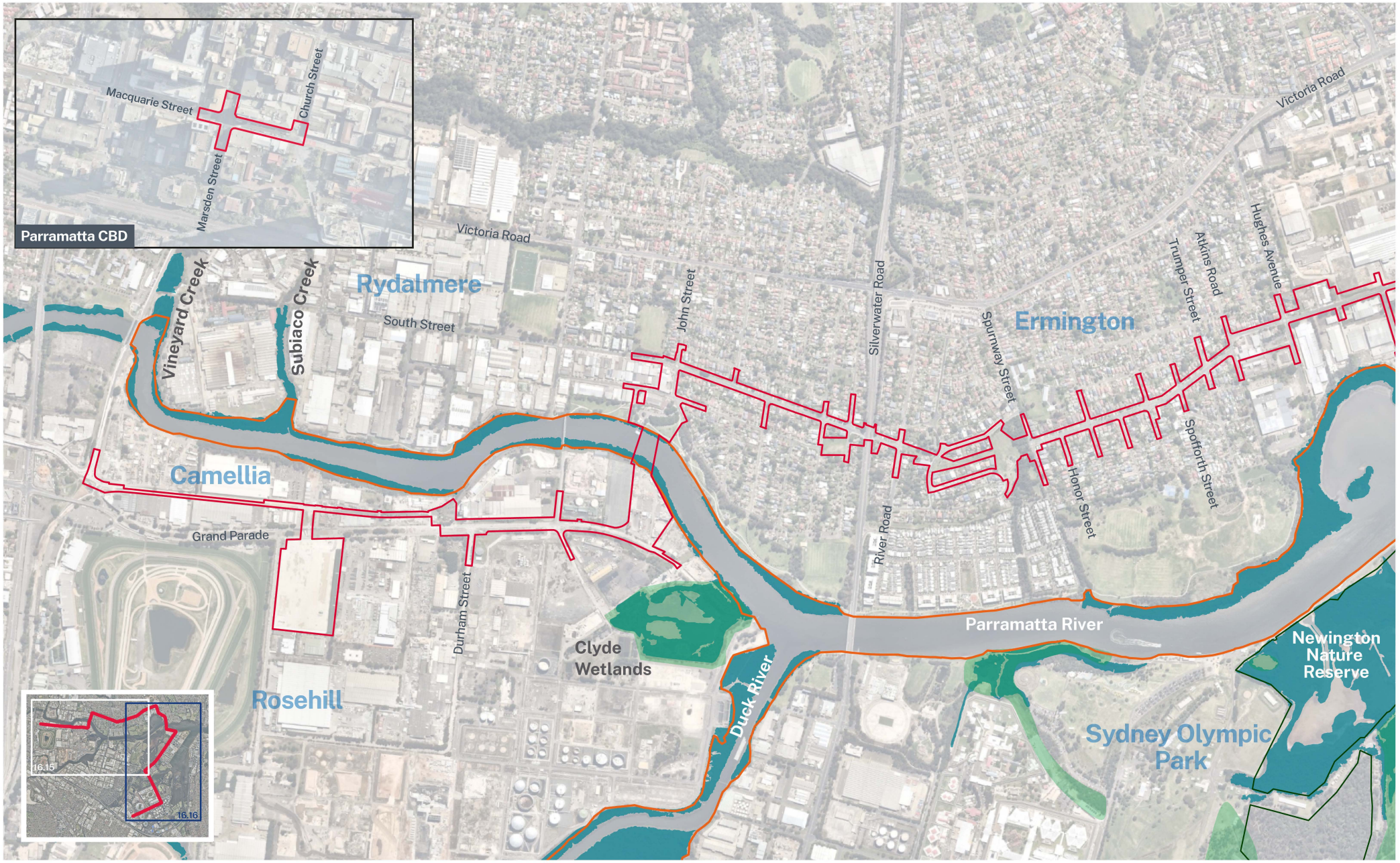


Figure 16.15 Protected and sensitive lands within the project site - map 1

LEGEND

- Project site
- Nature Reserve
- Coastal Wetlands
- Important Habitat for Migratory Species
- Green and Golden Bell Frog habitat (from SOPA 2019)

N

0 500m

Figure 16.16 Protected and sensitive lands within the project site - map 2

16.3 Assessment of construction impacts

Potential impacts on biodiversity during construction include:

- direct impacts as a result of vegetation clearing and disturbance in the project site
- indirect impacts on flora and fauna located outside the project site as a result of activities within the project site.

A summary of the results of the assessment is provided in the following sections.

16.3.1 Terrestrial flora and ecological communities

Vegetation clearing

Vegetation would need to be cleared to construct the project. About 8.34 hectares of vegetation would need to be removed, which includes about 5.79 hectares of planted vegetation and about 2.55 hectares of native vegetation (see Table 16.2 for a breakdown of the types of vegetation in the project site and their conservation status).

The majority of direct impacts would affect PCT 920 (Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion). It is estimated that about 0.91 hectares of this community would be impacted. This community is not a threatened ecological community but is classified as protected marine vegetation under the FM Act.

Vegetation clearing would remove non-threatened native plants from locally occurring communities and introduced plant species, including priority and high threat weeds. This reduction in the extent of native vegetation is less significant at the regional scale and is unlikely to threaten the persistence of any populations of native plants and vegetation communities. It is unlikely that an ecologically significant proportion of any regional plant populations would be located entirely within the project site.

Impacts on threatened ecological communities

The threatened ecological communities that would be directly impacted are listed in Table 16.8.

Table 16.8 Direct impacts on threatened ecological communities

Threatened ecological community	Corresponding PCT (see Table 16.2)	Extent of impact (hectares)
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC, BC Act)	PCT 1071	0.07
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (EEC, BC Act) Subtropical and Temperate Coastal Saltmarsh (VEC, EPBC Act)	PCT 1126	0.05
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (EEC, BC Act)	PCT 1234 (moderate condition)	0.01
	PCT 1234 (poor condition)	0.20
	PCT 1234 (planted)	0.26
Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion (CEEC, BC Act)	PCT 1281 (planted)	1.05
Total area impacted		**1.64**

Summary of impacts on communities listed under the BC Act

The project would directly impact the following threatened communities listed under the BC Act:

- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions
- Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion.

The amount of vegetation that would be directly impacted in these communities, and which would need to be offset, is listed in Table 16.8.

In relation to these potential impacts, an assessment of the potential for 'serious and irreversible impacts' to the Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion was determined to be required and has been prepared (see section 9.5 of Technical Paper 9 (Biodiversity Development Assessment Report)). The assessment found that the loss of a small area of planted vegetation (1.05 hectares) is unlikely to result in a substantial impact to the natural geographic extent of the community, given the landscape context in which the planted stand occurs (i.e., planted on an artificial soil profile, no natural soil seed back and is unlikely to be contributing to the overall ecological function of any natural remnants of this community).

Summary of impacts on communities listed by the EPBC Act

The project would directly impact about 0.05 hectares of vegetation of the Subtropical and Temperate Coastal Saltmarsh community, which is listed as vulnerable under the EPBC Act. The community is also classified as Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions by the BC Act (see Table 16.8). An assessment of significance is not required for vulnerable communities.

There would be no direct impacts on good quality patches of Sydney Turpentine Ironbark Forest of Coastal Swamp Oak Forest that meet the EPBC Act condition criteria. As such no assessment of significance has been prepared for this community.

Impacts on listed threatened flora species

Summary of impacts on species listed by the BC Act

The known locations of the Narrow-leafed Wilsonia are outside the project site and would not be directly impacted but may be at risk of indirect impacts during construction (see section 16.3.6). However, the *Biodiversity Assessment Method* requires that a 30 metre buffer be applied. The buffer area overlaps 0.01 hectares of the project site, which would need to be offset.

Summary of impacts on species listed by the EPBC Act

As noted in section 16.2.5, no threatened flora species listed under the EPBC Act were identified in the project site and so there would be no direct impacts during construction.

16.3.2 Terrestrial fauna

Direct impacts

Potential direct impacts on fauna and their habitats are summarised in Table 16.9.

Table 16.9 Direct impacts on fauna

Impact	Description
Removal of habitat and habitat resources	The following would be removed: • up to 1.03 hectares of wetland vegetation that provides foraging and shelter habitat for shorebirds and wetland birds, and foraging and breeding habitat for microbats, frogs and reptiles • up to 7.31 hectares of woodland forest and planted vegetation that provides foraging and shelter habitat features for native fauna species in urban environments, including fallen timber, accumulations of leaf litter, and patches of dense shrubs. The total area of habitat removal is spread along the project site. Only a small proportion of the resources available in any given patch of habitat would be removed.
Removal of hollow-bearing trees	No hollow-bearing trees or stags with large hollows suitable for owls or cockatoos would be removed. Removal of mangroves would result in the loss of many small hollows suitable for microbats and other smaller fauna. Alternative resources would be available in mangroves present in adjacent areas, including along the Parramatta River, Haslams Creek and the Badu Mangroves. Large hollow-bearing trees suitable for birds and possums that are present within Newington Nature Reserve would not be affected.
Injury and mortality	Construction has the potential to result in the injury or mortality of some individuals of less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the project site during clearing activities and unable to move out of the area. This could include roosting microbats, nestlings, small lizards and frogs. The potential injury or mortality of other individuals is unlikely to affect an ecologically significant proportion of any local populations. More mobile native fauna, such as native birds, bats, terrestrial and arboreal mammals, that may be sheltering in vegetation within the project site are likely to evade injury.
Fragmentation and isolation of habitat	Native vegetation within the project site is fragmented by existing urban development and roads. The project would be unlikely to create an additional barrier to the movement of pollinator and seed dispersal fauna, such as insects and birds. Clearing of vegetation in the Sydney Olympic Park and Wentworth Point area would comprise removal of disturbed edges and planted trees adjacent to existing roads and walkways. No areas of habitat would become isolated. Excavation for the light rail tracks and bridge works on Hill Road may temporarily affect some Green and Golden Bell Frog underpasses. Movement of this species in the Narawang Wetland would not be affected. Construction of the bridges across the Parramatta River would remove some areas of mangrove and saltmarsh vegetation, reducing riparian connectivity along the river. Construction may also temporarily prevent the movement of terrestrial fauna along riverbanks. However, there is likely to be some regrowth of mangroves following construction and it is unlikely that fauna movement would be permanently affected.

Impacts on listed threatened fauna species

Summary of impacts on species listed by the BC Act

The project would remove known habitat associated with the following key threatened fauna species and require species credit offsets:

- Green and Golden Bell Frog
- Southern Myotis
- Bar-tailed Godwit
- Black-tailed Godwit
- Curlew Sandpiper.

The project site is outside the *Biodiversity Assessment Method* designated buffer area of the White Bellied Sea Eagle nest tree; however, this species has been assessed for indirect impacts (see section 16.3.6).

An assessment of the potential for serious and irreversible impacts to the Curlew Sandpiper was determined to be required and has been prepared (see section 9.5 of Technical Paper 9 (Biodiversity Development Assessment Report)). The assessment found that the project would result in an impact on the Curlew Sandpiper as a result of the removal of about 0.59 hectares of land mapped as important habitat. This comprises small patches of mangroves, and linear fragments of saltmarsh and freshwater wetlands located alongside roads and paths. No large expanse of good quality mudflat habitat would be removed. The impacted habitat is a small portion of available habitat in the area, and individuals would still be able to forage in the wider area. The impacted habitat is also considered to represent a negligible proportion of the Curlew Sandpiper's geographic range. The potential for indirect impacts associated with flooding is considered in section 16.4.1.

Summary of impacts on species listed by the EPBC Act

The project would remove known habitat associated with fauna species listed under the EPBC Act. Assessments of significance were prepared for the following species:

- threatened species:
  - Green and Golden Bell Frog
  - Grey-headed Flying-fox
  - wetland birds (Australian Painted Snipe and Australasian Bittern)
  - threatened waders (Bar-tailed Godwit, Curlew Sandpiper, Eastern Curlew and Great Knot)
- migratory species:
  - Latham's Snipe
  - other migratory species.

The assessments found that the project was not likely to have a significant impact on the species listed above, with the exception of the Green and Golden Bell Frog. This was a result of the presence of a key population of the Green and Golden Bell Frog in the Millennium Parklands and Newington Nature Reserve, and the removal of habitat during construction (about 0.72 hectares) along with other indirect impacts and changes to hydrology (see section 16.4.1). The mitigation and management measures developed as an outcome of the assessment (see section 16.6) include measures to minimise the potential for identified impacts.

16.3.3 Aquatic habitats

The project would directly impact the mangrove forest and saltmarsh in the project site (shown on Figure 16.1 to Figure 16.6), requiring removal of about 0.91 hectares of mangrove forest (PCT 920) and 0.05 hectares of saltmarsh (PCT 1126), which are listed as protected marine vegetation under the FM Act. The project would not directly impact any habitat for threatened aquatic species listed under the EPBC Act or FM Act.

The project includes construction of new bridges across the Parramatta River, which is mapped as key fish habitat. Construction of watercourse crossings has the potential to create instream barriers, impact mangroves, increase erosion and interfere with natural flow regimes. Removal of mangroves may lead to localised foreshore erosion and riverbank destabilisation. Following the completion of the construction works, it is likely that the mangroves would regenerate in some disturbed areas.

16.3.4 Groundwater dependent ecosystems

The potential for impacts on groundwater dependent ecosystems are summarised in Table 16.10. The potential for impacts on groundwater is considered in Chapter 17 (Water). Potential contamination impacts are considered in Chapter 18 (Soils and contamination). Mitigation measures provided in sections 17.6 and 18.6 would be implemented to manage the potential impacts identified, which would minimise potential impacts on groundwater dependent ecosystems.

Table 16.10 Impact on groundwater dependent ecosystems

Location	Potential impacts
Mangroves at Melrose Park	The project would be elevated above the water table and no impacts on groundwater flow directions are expected.
Sydney Turpentine-Ironbark Forest and mangroves near Hill Road	This area overlies acid sulfate soils, the underlying groundwater contamination risks are moderate and salinity hazards are very high.
Mangroves at Haslams Creek / Holker Busway	Construction at this location is generally within the road corridor. Potential impacts include contamination risks due to accidental spillages and the generation of sediment.
Mangroves at Haslams Creek / Hill Road	The project is unlikely to impact groundwater levels. Potential impacts include impacts on water quality (surface and groundwater) due to accidental contaminant spillages or acid sulfate soils.

16.3.5 Key threatening processes

The BC Act, FM Act and EPBC Act list a series of key threatening processes. These are defined as a process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.

The project itself does not constitute a key threatening process. The project would exacerbate the following key threatening processes during construction and operation:

- clearing of native vegetation (BC Act and EPBC Act)
- loss of hollow-bearing trees (BC Act)
- predation by the Plague Minnow (*Gambusia holbrooki*) (BC Act)
- degradation of native riparian vegetation along NSW watercourses (FM Act).

In addition, the project has the potential to result in the following key threatening processes, mainly during construction:

- alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (BC Act)
- removal of dead wood and dead trees (BC Act)
- invasion of plant communities by perennial exotic grasses (BC Act)
- invasion and establishment of exotic vines and scramblers (BC Act)
- invasion of native plant communities by African Olive *Olea europaea* subsp. *Cuspidate* (BC Act)
- invasion, establishment and spread of Lantana (*Lantana camara L. sens. lat*) (BC Act)
- introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (BC Act)
- infection of frogs by amphibian chytrid causing the disease chytridiomycosis (BC Act and EPBC Act)
- infection of native plants by *Phytophthora cinnamomic* (BC Act and EPBC Act)

- installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams (FM Act)
- the removal of large woody debris from NSW rivers and streams (FM Act).

16.3.6 Indirect impacts

A summary of the potential indirect impacts is provided in Table 16.11.

Table 16.11 Indirect impacts on biodiversity values

Impact	Description
Edge effects and weed invasion	'Edge effects' include increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. The project site and adjoining areas have been moderately disturbed through urbanisation and previous development along the Parramatta River and Sydney Olympic Park. Weeds are prevalent around existing disturbed edges and in cleared areas, and there is a moderate to high risk of construction activities spreading new weeds into adjoining vegetation.
Introduction and spread of pests and pathogens	Construction activities, particularly vegetation clearing and the movement of construction vehicles, have the potential to increase the spread, introduction and establishment of weed and pest species, and diseases and pathogens. These could include plant pathogens (such as Phytophthora and Myrtle Rust) and frog pathogens (Chytrid fungus). The potential for significant or new impacts associated with these pathogens is relatively low, given the existing development and extent of human visitation across the project site and surrounding study area.
Noise and light impacts on fauna	Noise and light can indirectly affect breeding, foraging and roosting activities where fauna are located close to construction activities, particularly in environments that are not already subject to these affects. Fauna that occupies habitats within the project site and adjacent areas would be used to a level of noise and light disturbance from road and river traffic and the urban environment. However, fauna most at risk would be those residing near work areas, and, in particular, any species that may be nesting, roosting or denning in the area. Technical Paper 9 (Biodiversity Development Assessment Report) identified that the Southern Myotis and nearby White-bellied Sea-eagle nest (located about 300 metres from the project site) would be at most risk from noise impacts during their respective breeding seasons. Given the temporary nature of the works, and the availability of alternate habitat in surrounding areas, it is unlikely the temporary increase in noise during construction would significantly impact on fauna that occur in the project site.
Aquatic disturbance	If inadequately managed, construction has the potential to result in sedimentation and erosion within the project site and adjoining native vegetation and aquatic habitats. It also has the potential to mobilise contaminated sediments into waterways, or result in chemical spills from vehicles or plant. The introduction of pollutants from the project into the surrounding environment, if uncontrolled, could impact on water quality further downstream. These potential impacts would be managed by implementing standard best practice construction management measures, including sedimentation and erosion controls.
Dust	If inadequately managed, construction has the potential to generate dust. High dust levels (and any pollutants it may contain) could reduce habitat quality for flora and fauna species by reducing plant and animal health in adjacent areas of vegetation. Dust may affect photosynthesis, respiration and transpiration in plants, and allow the penetration of gaseous pollutants. Dust could also impact fauna health. The potential for dust generation would be managed by implementing standard construction management measures.

Impact	Description
Fire	Construction presents a potential risk of fire, for example from storage of combustible fuels or ignition from works areas. Given the location of the project site in a predominantly urban area, the risk of accidental fire is low. The risk of fires spreading to adjacent areas would be minimised by implementing appropriate measures during construction to contain and control the outbreak of fire.

16.3.7 Protected and sensitive lands

Potential impacts on protected and sensitive lands in the study area are summarised in Table 16.12.

Table 16.12 Summary of impacts on protected and sensitive lands within the study area

Protected and sensitive lands	Impact
Coastal wetlands and Narawang Wetland	The project would result in the removal of native vegetation within areas of mapped coastal wetlands at the Parramatta River, and narrow linear fragments along the edge of Narawang Wetland adjacent to Hill Road. Potential impacts include: • clearing of 2.55 hectares of native vegetation, including mangroves, saltmarsh, Swamp Oak Forest, Freshwater Wetlands and planted Sydney Turpentine-Ironbark Forest • potential for indirect impacts, including erosion and sedimentation, and mobilisation of contaminants • changes to flow regimes, particularly with regards to minor flooding immediately upstream of the bridge between Melrose Park and Wentworth Point, and within Narawang Wetland (considered further in section 16.4.1).
High biodiversity values land – important habitat for migratory waders	The project would remove 0.59 hectares of mapped important habitat for the Bar-tailed Godwit and Curlew Sandpiper. This comprises patches of mangroves, saltmarsh, Swamp Oak Forest and rushland. No large mudflats would be removed.
Protected areas	No construction activities would occur in the Newington Nature Reserve. The proposed bridge between Melrose Park and Wentworth Point is located close to the Newington Nature Reserve Wetland. There would be no direct impact on the White-bellied Sea-eagle nest located in the reserve. It is estimated that the project could marginally increase the height of flooding in Newington Nature Reserve by 10 to 50 millimetres (see Chapter 17 (Water)). The duration of flooding may be incrementally longer, potentially affecting the extent of saltmarsh. However, an increase in flood frequency is not anticipated. The proposed new bridge over the Parramatta River would shade areas adjacent to the project site that are not currently subject to shade, including a small area within the Newington Nature Reserve Wetland (see section 16.4.2). Shading can adversely affect vegetation and associated habitats.
Key fish habitat and waterfront land	Waterfront land is located within 40 metres of the banks of the Parramatta River and Haslams Creek. Potential impacts include: • clearing of marine vegetation (0.91 hectares of mangroves and 0.05 hectares of saltmarsh) and riparian vegetation (0.47 hectares of Swamp Oak Forest) • removal of large woody debris • construction of instream structures (bridge piers) within the Parramatta River • potential indirect impacts, including erosion and sedimentation, and mobilisation of contaminants • changes to flow regimes, particularly with regards to minor flooding immediately upstream of the bridges.

Protected and sensitive lands	Impact
Offset sites	No biodiversity stewardship sites or private conservation lands are located in the study area. Parts of the Millennium Parklands are zoned for conservation, and include habitats created as compensatory habitat for the Green and Golden Bell Frog. Clearing of vegetation would remove areas of foraging and movement habitat for the Green and Golden Bell Frog; however, no ponds would become permanently isolated. Impacts on native vegetation and habitat for the Green and Golden Bell Frog would be offset in accordance with the *Biodiversity Assessment Method* (see section 16.6.3). The project would remove 1.05 hectares of vegetation planted to recreate Sydney Turpentine-Ironbark Forest, located at the northern end of the Millennium Parklands. This vegetation was planted to provide habitat for small woodland birds. The impacts on planted vegetation in the Millennium Parklands would affect habitats created to provide habitat for a range of fauna. These habitats are still relatively young and have not yet gained their full value. For example, mature trees with hollows are generally lacking in this area, as hollows take decades to form. The removal of this vegetation would reduce the area for creation of future habitat features such as hollows, which are a critical resource for many fauna species. Measures are provided in section 16.6 to minimise these potential impacts as far as practicable.

16.3.8 Additional impacts that require consideration

In accordance with the *Biodiversity Assessment Method*, assessment of biodiversity values, in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat are required. For many of these impacts, the biodiversity values may be difficult to quantify, replace or offset, making avoiding and minimising impacts critical. Clause 6.1 of the BC Regulation requires the following prescribed actions to be assessed under the NSW Biodiversity Offsets Scheme. These include, where they relate to the project:

- human-made structures – noise and vibration from construction activities on Hill Road near Holker Street could disturb roosting microbats and potentially result in mortality of individuals
- non-native vegetation – the project would remove 5.79 hectares of planted vegetation
- habitat connectivity – there is the potential for impacts on fauna connectivity within the riparian zone
- hydrological processes – construction of bridge infrastructure could impact mangroves, increase erosion and interfere with natural flow regimes
- vehicle strike – potential impacts during construction would be limited, given the location of much of the project site along existing roads.

16.4 Assessment of operation impacts

Operation has the potential to result in the following impacts:

- change to hydrological processes and water quality, and associated potential for impacts on aquatic biodiversity
- shading of mangroves associated with the new bridges over the river
- introduction of artificial lighting, which can disorient flying birds, particularly during migration, and cause them to divert from efficient migratory routes or collide with infrastructure
- injury and mortality of birds and bats from overhead wiring
- injury and mortality of fauna attempting to cross the new light rail line (vehicle strike).

These potential impacts are described below.

16.4.1 Changes to hydrological process and water quality

The project is expected to have minimal impact on coastal processes and overall current and wave conditions within the Parramatta River estuary. Riparian and mudflat habitat outside the project site are unlikely to be affected by changes to currents or wave conditions.

There is potential for scour around the proposed bridge piers caused from localised changes in flow currents and turbulence around this section of the river. Scour due to the proposed bridges is expected to be localised in nature and confined to areas in the direct vicinity of the flood flow-exposed piers (see Chapter 17 (Water)). The abutments of the two proposed bridges would encroach on the main channel of the river; however, the tidal waterway blockage caused by the new bridges would be small in comparison to the unrestricted waterway area and would not block fish passage.

Increases in impervious surfaces could result in the build-up of contaminants in dry weather. During rainfall events these could be transported to surrounding watercourses as stormwater and wastewater. The project includes design features to manage stormwater runoff, which would minimise impacts on adjacent wetland and waterway habitat.

Increases in impervious areas could result in an increase in surface runoff volumes and peak flows, resulting in increased flood levels. The two new bridges could cause increases in flood levels at properties that are already impacted by flooding, including foreshore properties on the Parramatta River. The presence of bridge infrastructure in the Parramatta River floodplain may reduce the efficiency of the floodplain in conveying flood water downstream, resulting in higher flood levels on the upstream side of the bridge structures. The current flood depths in the Newington Nature Reserve Wetland are upwards of 0.5 metres (up to one to two metres in places), with the increase in flood levels limited to 50 millimetres in the one per cent AEP flood event. With this slight increase in flood level there may be longer periods of freshwater inundation. Over time, this may influence the extent of saltmarsh and Narrow-leafed Wilsonia.

The potential change in flooding regimes is unlikely to substantially affect foraging habitat for migratory waders.

16.4.2 Shading

The proposed bridges over the Parramatta River would shade areas of vegetation adjacent to the project site that are not currently subject to shade. Shading may have a greater impact on overall structure and function of mangroves and saltmarsh than the initial construction of the bridges, as shading by structures may adversely affect vegetation and overall net primary production (Struck et al, 2004).

The biodiversity assessment included modelling the predicted shade impacts. A conservative approach has been taken, and it is assumed that any areas of vegetation that receive more shading once the bridges are built than they do now, are likely to die off or undergo substantial floristic or structural changes, rendering them in a poorer ecological state than they are now.

It is estimated that the project has the potential to result in shading impacts on:

- 1.13 hectares of Mangrove Forests in estuaries (PCT 920)
- 0.07 hectares of Saltmarsh in estuaries (PCT 1126)
- 0.10 hectares of Swamp Oak swamp forest fringing estuaries (PCT 1234).

The native vegetation that would be subject to shade impacts also comprises:

- 0.07 hectares of habitat for Narrow-leafed Wilsonia
- 0.37 hectares of habitat for the Green and Golden Bell Frog
- 1.30 hectares of habitat for the Southern Myotis
- 1.10 hectares of habitat for the Curlew Sandpiper

- 1.10 hectares of habitat for the Bar-tailed Godwit
- 1.20 hectares of habitat for the Black-tailed Godwit.

16.4.3 Lighting

Fauna in the vicinity of the project site is considered to be habituated to lighting, given the existing urban setting. However, the introduction of additional lighting from the project may further impact fauna activity in the study area, particularly in areas adjacent to native vegetation and parklands such as Sydney Olympic Park, Newington Nature Reserve and on the bridges over the Parramatta River.

16.4.4 Overhead wiring

Fauna species at risk of collision or electrocution from powerlines, or in the case of the project, catenary overhead wiring, could include raptors (birds of prey), migratory species (if wires cross their natural migration pathways), Grey-headed flying-foxes, and the White-bellied Sea-eagle. However, there would be a relatively minor increase in risk of injury and mortality for these species given the presence of existing overhead wiring and/or other built structures throughout the project site.

16.4.5 Vehicle strike

The project has the potential to result in injury and mortality through light rail vehicle strike. Threatened fauna within the study area are already at risk of vehicle strike due to the urban environment. However, given the lack of substantial areas of habitat to support large populations of native fauna, vehicle strike rates are anticipated to remain relatively low.

16.5 Cumulative impacts

The main potential for cumulative biodiversity impacts relates to the combined impacts of the project with current and future urban renewal activities and development projects in the study area. The various projects that are underway and proposed would result in the removal of mainly planted vegetation and associated fauna habitats within existing disturbed and developed areas. Cumulatively, these projects would result in a minimal loss of biodiversity values. The main potential cumulative impact would be the further loss of habitat from an already modified environment with limited natural biodiversity values.

16.6 Mitigation and management measures

16.6.1 Approach to mitigation and management

The overall approach to managing impacts on biodiversity is, in order of importance, to:

- avoid impacts through the planning and design process
- mitigate impacts using a range of mitigation measures
- offset any residual impact that could not be avoided or mitigated as required by relevant legislation.

The majority of the project site is located on land that has been modified by clearing and development (including road construction). Project infrastructure has been located to maximise the use of existing cleared areas and avoid areas of native vegetation as far as practicable. The design would continue to be refined to minimise direct impacts on native vegetation as far as practicable.

The project would mainly impact existing cleared and hardstand areas with no or limited biodiversity values. A small area (about 2.55 hectares) of native vegetation would be removed and offset under relevant legislation.

Measures are provided in section 16.6.2 to mitigate impacts that cannot be avoided. The potential for impacts during construction would be managed in accordance with a project-specific biodiversity management plan, which would be prepared and implemented as part of the CEMP. The plan would detail processes and responsibilities to minimise potential impacts on biodiversity during construction. Further information on the CEMP is provided in Chapter 23 (Approach to environmental management and mitigation).

The proposed approach to offsetting residual impacts is described in section 16.6.3.

Measures to minimise potential impacts associated with noise, flooding and water quality, soils and contamination, and air quality would assist in minimising potential indirect impacts on biodiversity. These mitigation measures are provided in Chapters 10 (Noise and vibration), 17 (Water), 18 (Soils and contamination) and 20 (Air quality).

16.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on biodiversity are listed in Table 16.13.

Table 16.13 Biodiversity mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Avoiding impacts on biodiversity	BD1	Vegetation clearing will be limited to the minimum necessary to construct the project. The design and location of infrastructure will be further refined during each design phase to minimise or avoid impacts on native vegetation and fauna habitat as far as practicable.	Design
Offsetting impacts on native vegetation and threatened species	BD2	Biodiversity offsets will be finalised in accordance with the NSW Biodiversity Offsets Scheme and the NSW Assessment Bilateral Agreement under the EPBC Act, in consultation with the NSW Department of Planning and Environment (Environment, Energy and Science Directorate). Offsets required under the *Fisheries Management Act 1994* will be finalised consultation with DPI Fisheries.	Design
Habitat connectivity impacts – Sydney Olympic Park	BD3	Design development in Sydney Olympic Park and the Millennium Parklands will ensure that habitat connectivity and quality for the Green and Golden Bell Frog is maintained in consultation with Sydney Olympic Park Authority.	Design
	BD4	The use of overhead wiring will be minimised as far as practicable in areas adjoining Grey-headed Flying-fox foraging habitat and the flight paths of the White-bellied Sea-eagle and migratory waders, particularly on the bridges over the Parramatta River, adjacent to Newington Nature Reserve, and around Hill Road and the Holker Busway.	Design
Impacts to habitat values	BD5	The planting of feed trees for the Grey-headed Flying-fox will be considered to improve habitat values at Wentworth Point and Sydney Olympic Park, with a particular focus on locally indigenous winter-flowering species, such as Forest Red Gum (*Eucalyptus tereticornis*), Spotted Gum (*Corymbia maculata*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*).	Design
	BD6	Landscaping will use locally indigenous species to buffer the light rail alignment adjacent to vegetated areas, including Newington Nature Reserve, and along Hill Road and the Holker Busway.	Design
	BD7	Opportunities to minimise light pollution to ecologically sensitive areas, particularly the Parramatta River, Newington Nature Reserve and the Millennium Parklands, will be investigated and implemented where reasonable and feasible, with regard to the *National Light Pollution Guidelines for Wildlife* (Department of the Environment and Energy, 2020).	Design

Impact/issue	Ref	Mitigation measure	Timing
	BD8	The design of the proposed bridges over the Parramatta River, and works to bridges in Sydney Olympic Park, will include provision for bat-friendly roost features. Bat-friendly roost features, and the use of nest boxes appropriate for use by microbats, will also be investigated and installed at other locations, where appropriate.	Design
Habitat impacts – Sydney Olympic Park	BD9	Habitat connectivity and quality for the Green and Golden Bell Frog will be maintained during construction. This will include replacing any Green and Golden Bell Frog underpasses with the potential to be affected during construction with an equivalent structure, in consultation with Sydney Olympic Park Authority.	Construction
	BD10	Construction measures to avoid impacts on breeding of threatened fauna, such as the White-bellied Sea-eagle and Southern Myotis, will be implemented where feasible and reasonable. Such measures, including timing of construction, quieter construction methods, and/or the use of temporary noise barriers, will be implemented where feasible and reasonable, for works at: • Holker Busway (to minimise impacts on the breeding of the Southern Myotis during October to April) • Hill Road near the White-bellied Sea-eagle nest (breeding season from July to January).	Construction
	BD11	Where existing frog-proof fencing within Sydney Olympic Park is impacted by the project, temporary frog-proof fencing will be installed around work areas. Permanent frog-proof fencing will be reinstated following construction.	Construction
Impacts on mangrove vegetation	BD12	Impacts on estuarine mangrove vegetation at Haslams Creek will be avoided or minimised as far as practicable. Works on the Holker Busway bridge will be undertaken via scaffolding attached to the bridge where practicable, rather than from the ground, to minimise impacts on estuarine mangrove vegetation.	Construction
General biodiversity impacts and management	BD13	A biodiversity management plan will be prepared prior to construction and implemented as part of the CEMP. The plan will include measures to protect biodiversity and minimise the potential for impacts during construction. The plan will include but not be limited to: • measures to manage biosecurity risks (including pathogens and weeds) in accordance with the *Biosecurity Act 2015* (NSW) • locations and requirements for pre-clearing surveys, including where clearing is required within Sydney Olympic Park and areas of mangrove, saltmarsh or other riparian vegetation (see mitigation measure BD14) • an unexpected finds procedure • hygiene controls in relation to chytrid fungus, cinnamon fungus (*Phytophthora cinnamomi*) and myrtle rust (*Pucciniales fungi*) • locations and procedures for monitoring (see mitigation measures BD16 to BD18). The plan will be developed in accordance with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority (RTA), 2011). Management measures for works within Sydney Olympic Park and the Millennium Parklands will be developed in consultation with Sydney Olympic Park Authority.	Construction

Impact/issue	Ref	Mitigation measure	Timing
	BD14	Pre-clearing surveys will be completed prior to any works (including minor works) within sensitive areas, including at the following locations: • vegetated land within Sydney Olympic Park • areas of mangrove, saltmarsh or other riparian vegetation. • areas identified by the project ecologist as supporting known or potential habitat, for ground-dwelling and arboreal species. Pre-clearing surveys will be undertaken in accordance with Guide 1 (Pre-clearing process) of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	Pre-construction
Rehabilitation and revegetation	BD15	The rehabilitation strategy (mitigation measure LP9) will include a revegetation plan, prepared and implemented in consultation with relevant stakeholders, including Sydney Olympic Park Authority and landowners. The revegetation plan will include: • clear objectives for rehabilitation and re-establishment of native vegetation in temporary disturbance areas, in accordance with Guide 3 (Re-establishment of native vegetation) of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) • active revegetation of mangroves at the proposed bridges over the Parramatta River • requirements for ongoing monitoring.	Construction
Monitoring	BD16	A fauna monitoring program, including monitoring locations, methods and timing, will be developed and implemented in consultation with Sydney Olympic Park Authority ecologists and Birdlife Australia, using available baseline data. The program will include monitoring during construction of: • frog fencing • microbat roosts (for any works along the Holker Busway during the microbat breeding season) • the response of the White-bellied Sea-eagle to construction noise.	Construction
	BD17	Monitoring of indirect impacts on mangroves, saltmarsh and the Narrow-leafed Wilsonia (*Wilsonia backhousei*) population will be undertaken during and following construction. If an incident occurs in these areas, monitoring by a suitably qualified expert is required to determine the severity and potential need for additional offsets under the *Biodiversity Assessment Method* (DPIE, 2020b).	Construction
	BD18	The behavioural response of the White-bellied Sea-eagle to operation will be monitored in consultation with Sydney Olympic Park Authority ecologists and Birdlife Australia during the first two years of operation.	Operation

16.6.3 Offsetting

Biodiversity offset requirements under the BC Act

The offsets required to compensate for the residual biodiversity impacts under the BC Act were determined using the Biodiversity Assessment Method Calculator. In accordance with the offset rules established by the BC Regulation, offset obligations can be achieved by retiring appropriate biodiversity credits from an established Biodiversity Stewardship Site, monetary payment directly into the Biodiversity Conservation Fund, or funding an approved biodiversity action.

A total of 22 ecosystem credits are required to offset the project's impacts on native vegetation listed under the BC Act.

The project site is known or assumed to support six species credit species, requiring a total of 93 species credits. Species credits have been calculated for the following species:

- Narrow-leafed Wilsonia (*Wilsonia backhousei*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Southern Myotis (*Myotis Macropus*)
- Curlew Sandpiper (*Calidris ferruginea*)
- Bar-tailed Godwit (baueri) (*Limosa lapponica baueri*)
- Black-tailed Godwit (*Limosa limosa*).

Offsetting for operational or prescribed impacts on threatened biota

Operational or prescribed impacts are difficult to quantify compared to direct, or even indirect, impacts (DPIE, 2020b). The consent authority has the discretion to increase the number of biodiversity credits to be retired (or other conservation measures to be undertaken), if the justification is due to environmental, social and economic impacts of a proposed development (see section 7.13(4) of the BC Act and clause 6.1.2(b) of the BC Regulation). Given there is no set method for determining a suitable quantum of credits to offset a prescribed impact, the assessor should clearly document the decision pathway and justification for suggested credit numbers or other compensatory actions in the Biodiversity Development Assessment Report. Any biodiversity credits proposed are then additional to the baseline number of biodiversity credits determined by the *Biodiversity Assessment Method* (DPIE, 2020b).

The two new bridges over the Parramatta River would result in patches of vegetation surrounding the base of these bridges receiving less sunlight. This operational change has the potential to impact the health of this vegetation, with impacts ranging from death or dieback, through to changes in structural or floristic composition and diversity. To account for these potential impacts, a worst-case scenario has been assumed, and all vegetation that would receive new shade from the presence of the bridges has been considered unlikely to survive. To account for the impacts of shading over the operational life of the project, it is recommended that biodiversity offsets be provided.

A total of 23 ecosystem credits and 101 species credits are required for the project to offset shading impacts of the project. These biodiversity offsets would be included in the total credit obligation for the project.

Offsetting for impacts on key fish habitat

Under the *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) impacts on key fish habitat are to be offset by compensatory works to ensure no net loss. These offsets are in addition to offsets required under the *Biodiversity Assessment Method* for the same vegetation. The project would impact the following key fish habitat:

- removal of 0.91 hectares of mangroves
- removal of 0.05 hectares of saltmarsh
- construction of piers in the Parramatta River.

The Department of Primary Industries (DPI) Fisheries calculates habitat compensation on a minimum 2:1 basis for all key fish habitat lost, at a rate of around $56.75 per square metre (provided in December 2021). Based on this value, offsets would be around $1,032,096 for direct impacts on mangroves. Some revegetation of mangroves may be possible following construction; which can contribute to offset requirements under the FM Act.

Impacts on saltmarsh can be offset under either the BC Act of the FM Act, but do not need to be offset under both. If saltmarsh is to be offset under the FM Act rather than the BC Act, offsets would be around $41,267 for this community.

There would also be shading impacts on mangroves and saltmarsh, which may increase the offset liability for these communities. A calculation of offsets for pier construction would be undertaken once the design is confirmed and would include the area of impact of the piles and associated scour protection.

Transport for NSW would continue to liaise with DPI Fisheries regarding the potential for compensatory works, and the approach to calculating monetary offsets.

Biodiversity offset obligations under the EPBC Act — offset for significant impacts

The NSW and Australian governments have amended the bilateral agreement for environmental assessment (the bilateral agreement) after changes to NSW legislation. Amending Agreement no. 1 was signed on 24 March 2020. The Australian Government formally endorsed the NSW Biodiversity Offsets Scheme through the *EPBC Act Condition-setting Policy* (DAWE, 2020).

Under the bilateral agreement, only one decision, including conditions of approval, is made by the NSW Government, accounting for NSW matters of national environmental significance. The *EPBC Act Condition-setting Policy* notes that where a project demonstrates compliance with an endorsed State or Territory policy, the proponent will not be required to simultaneously comply with the corresponding Australian Government policy.

The project has been determined as a controlled action due to impacts on threatened species and ecological communities listed under the EPBC Act, in particular the Green and Golden Bell Frog. Species offset credits for the Green and Golden Bell Frog have been calculated in accordance with the *Biodiversity Assessment Method* (DPIE, 2020b) and would be delivered in accordance with the NSW Biodiversity Offset Scheme and BC Act, pursuant to the bilateral agreement.