

BIODIVERSITY

CHAPTER TWENTY

20 Biodiversity

This chapter provides an assessment of the biodiversity impacts as a result of the construction and operation of the project and identifies mitigation measures to minimise these impacts. This chapter draws on information in Technical paper 9 – Biodiversity.

20.1 Secretary’s environmental assessment requirements

The Secretary’s environmental assessment requirements relating to biodiversity, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 20-1.

Table 20-1 Secretary’s environmental assessment requirements – biodiversity

Ref.	Secretary’s environmental assessment requirements	Where addressed
5. Biodiversity		
5.1.	The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA).	The Framework for Biodiversity Assessment is addressed in Section 20.2.5.
5.2.	The Proponent must assess any impacts on biodiversity values not covered by the FBA as specified in s2.3.	The Framework for Biodiversity Assessment is addressed in Section 20.2.5.
5.3.	The Proponent must assess impacts on the following [EECs, threatened species and/or populations] and provide the information specified in s9.2 of the FBA.	Biodiversity impacts are addressed in Section 20.4.
5.4.	The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the <i>Threatened Species Conservation Act 1997</i> (TSC Act), <i>Fisheries Management Act 1994</i> (FM Act) and <i>Environmental Protection and Biodiversity Conservation Act 2000</i> (EPBC Act).	Biodiversity impacts are addressed in Section 20.4.
17. Hydrology		
17.1.	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA.	Hydrology in relation to biodiversity impacts is addressed in Section 20.3.1.
17.2. (a)	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Biodiversity impacts are addressed in Section 20.4.
17.2. (b)	impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement.	Groundwater dependent ecosystems are addressed in Section 20.3.6.

20.2 Assessment methodology

The project has been assessed in relation to key biodiversity policy and legislation and policy including:

- *NSW Biodiversity Offsets Policy for Major Projects – Framework for Biodiversity Assessment 2014* (Office of Environment and Heritage, 2014b)
- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Threatened Species Conservation Act 1995* (TSC Act)
- *Noxious Weeds Act 1993* (NW Act)
- *Environmental Planning and Assessment Act 1979* (EP&A Act)
- *Fisheries Management Act 1994* (FM Act).

20.2.1 Biodiversity study area

The study area for this assessment includes all areas where biodiversity values are potentially affected by the project. The project would have potential biodiversity impacts at eight sites:

- Chatswood dive site (northern)
- Artarmon substation
- Blues Point temporary site
- Sydney Harbour (ground improvement work)
- Barangaroo Station site
- Central Station
- Waterloo Station
- Marrickville dive site (southern).

20.2.2 Desktop research

Database searches

Two databases were searched to identify threatened entities listed under the TSC Act and EPBC Act (Commonwealth Matters of National Environmental Significance) known or likely to occur within ten kilometres of the project. These databases are:

- The NSW Bionet Wildlife Atlas – this is managed by the NSW Office of Environment and Heritage (OEH). A coordinate search was carried out to determine threatened species records listed under the TSC Act to within ten kilometres of the project. The search areas overlapped considerably and as such, search results were combined
- The Protected Matters Search Tool – this is managed by the Australian Government Department of the Environment (Department of the Environment). A coordinated search was carried out to determine threatened species, threatened ecological communities and migratory species listed under the EPBC Act known or likely to occur to within ten kilometres of the project.

Literature review

Reports, vegetation maps, topographic maps, aerial photography and literature were reviewed to provide an understanding of ecological values occurring or potentially occurring in the study area and wider region. This material included:

- *Soil Landscapes of the Sydney 1:100 000 Sheet* (Chapman and Murphy 1989)
- *Marrickville Biodiversity Strategy 2011–2021* (Australian Museum Business Services, 2011)
- *Urban Ecology Strategic Action Plan* (City of Sydney 2012c)
- *Urban Bushland Plan of Management Volume 1, Policy and Management Issues, 2014–2019* (Willoughby City Council, 2014)
- *The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area* (Department of Environment Climate Change and Water, 2009a).

20.2.3 Field survey

Terrestrial flora and fauna at seven sites within the study area were inspected in May and October 2015. These are listed in Table 20-2.

Table 20-2 Sites subject to biodiversity survey

Survey date	Site	Survey methods
25 May 2015	Barangaroo, part of Marrickville dive site (southern)	Diurnal site inspection
7 October 2015	Chatswood dive site (northern), Artarmon substation, Central Station, Waterloo Station	Diurnal site inspection, dusk / evening active Anabat survey (Chatswood dive site only)
8 October 2015	Waterloo Station	Dusk/evening active Anabat survey
17 February 2016	Blues Point temporary site, Marrickville dive site (southern)	Diurnal site inspection, dusk / evening active Anabat survey (Marrickville dive site only)

The site inspections involved:

- Detection and identification of native plant and animal species
- Detection and identification of environmental weeds and noxious weeds declared under the NW Act for the Willoughby, Sydney and Marrickville local government areas (LGAs)
- Assessment of fauna habitat values
- Searches for indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks, scratches and digging)
- Assessment of potential habitat for threatened flora and fauna species previously recorded within the locality
- Active Anabat surveys that comprised active recording on foot at dusk for one hour, with a hand-held spotlight used to view potential roosting locations when the light was low.

20.2.4 Likelihood of occurrence

The database searches identified threatened flora and fauna species that have been recorded or that are likely to occur within ten kilometres of the study area. The probability that each threatened species occurs within the study area was determined as being either low, moderate, high or known, based on criteria outlined in *Technical paper 9 – Biodiversity*.

20.2.5 Framework for Biodiversity Assessment

The impacts of the proposal on biodiversity were assessed using the methodology in the Framework for Biodiversity Assessment (FBA) (Office of Environment and Heritage, 2014b). All applicable sections of the FBA were addressed, as outlined in Section 20.5.

Given that no Plant Community Types listed in the NSW Vegetation Information System Database are located within the study sites, it was not possible to carry out an assessment using the FBA credit calculator.

20.3 Existing environment

20.3.1 Hydrology

The project intersects the estuary of Sydney Harbour, a drowned river valley formed during sea level rise about 10,000 years ago. The estuary opens up from the entrance to form Port Jackson, and then divides into three main branches, Middle Harbour to the north and the Parramatta and Lane Cove Rivers extending south, then westward away from the heads. The estuary is about 30 kilometres long, with a total catchment of 500 square kilometres (Sydney Institute of Marine Science, 2016). The project area lies to the east of the confluence of the Parramatta and Lane Cove rivers.

The bathymetry of Sydney Harbour is complex, and comprises dredged channels for shipping and a number of deep holes of about 28 to 45 metres, separated by shoals with depths of three to five metres (Sydney Institute of Marine Science, 2016). There is a 45 metre deep hole immediately to the east of the project area.

The project lies within a highly urbanised catchment, and all natural watercourses have been historically replaced with constructed drainage systems. The only mapped watercourse within the study area is the Eastern Channel which runs through the Marrickville dive site. The Eastern Channel is a concrete canal, built in the late 1890s (Sydney Water, 2014), which drains to the Sydenham Pit to the west of the Marrickville dive site. The proposed tunnel between Marrickville dive site and Waterloo Station runs beneath Sheas Creek, another concrete canal which forms the north-eastern extent of Alexandra Canal.

20.3.2 General site characteristics

Table 20-3 outlines the general site characteristics of each of the eight sites with potential biodiversity impacts.

Table 20-3 Site characteristics

Site	Location / description
Chatswood dive site (northern)	<p>Vegetation within the rail corridor between Albert Avenue in the north and Brand Street in the south, associated road bridges and the Ausgrid depot site immediately west of the rail corridor, between Mowbray Road and Nelson Street.</p> <p>The vegetation is characterised by planted native vegetation mixed with invasive exotic species. The Chatswood dive site has limited fauna habitat values due to lack of native vegetation, urban development and high levels of disturbance from road and rail traffic.</p> <p>Scattered trees are present within the Ausgrid depot site and around the southern boundary. A potential hollow-bearing tree was located in the middle of the depot. A nest box and a hollow-bearing tree were observed on the southern boundary of the depot. The remainder of the depot contains buildings and hardstand. Most buildings did not appear suitable for microbats. No microbats were recorded during Anabat surveys of this site.</p> <p>Two concrete road overbridges are present in this site. Crevices in the bridge deck could provide roosting habitat for microbats. The bridges are subject to high levels of road and rail traffic and as such, suboptimal for microbats. None were observed during targeted surveys.</p>
Artarmon substation	<p>Cleared block of land adjoining the northern side of the Gore Hill Freeway, south-west of residential apartment blocks on Barton Road.</p> <p>The vegetation of the Artarmon substation site comprised cleared grassland lined by trees and shrubs. The Artarmon substation site would provide some foraging and nesting habitat for common urban fauna. It otherwise has limited habitat value for fauna due to the disturbed nature of the site including urban development and roads.</p>
Blues Point temporary site	<p>Cleared grassland at southern end of Blues Point Road and south of Henry Lawson Avenue, adjoining Sydney Harbour.</p> <p>The site has limited fauna habitat value, though shorebirds could occur as vagrants on the shoreline or in grassland behind it.</p>
Sydney Harbour (ground improvement work)	<p>Ground improvement works would be undertaken in Sydney Harbour between Blues Point and Millers Point. Ground improvement work is likely to be carried out at the rock-sediment transition zones between 30 to 40 metres below the sea bed. The sediments within Sydney Harbour provide habitat for benthic infauna and epifauna. Common recreational fish species and sharks and marine mammals also known to occur in Sydney Harbour.</p>
Barangaroo Station site	<p>The vegetation of this site consists of planted street trees within a highly modified urban context along Hickson Road between the southern extent of High Street and the Munn Street tunnel to the north. Fauna habitats at the Barangaroo site are restricted to scattered planted street trees and a small patch of landscaped vegetation with palm trees, succulents and grasses. Street trees would provide foraging habitat and shelter for common fauna adapted to urban environments. Fig trees at this site could provide foraging habitat for the Grey-headed Flying-fox when fruiting.</p>

Site	Location / description
Central Station	In the strip between the suburban and country railway lines, known as ‘Sydney Yard’, is mostly hardstand with a railway platform, a few planted / regenerating trees and buildings. The site has limited fauna habitat value due to the highly disturbed and developed nature of the site. It is possible that buildings could provide roosting habitat for microbats, though unlikely due to their location within the middle of a busy railway station.
Waterloo Station	Industrial and commercial buildings on the block bounded by Botany Road, Raglan Street, Cope Street and Buckland Street. The Waterloo site was comprised entirely of buildings and there was no vegetation observed on the site. The buildings at the Waterloo study site were inspected from the outside at street level. Based on this inspection, the buildings did not appear suitable for microbats due to the high levels of activity within, lack of suitable insulation and lack of entry / exit points.
Marrickville dive site (southern)	Industrial lands on northern and southern sides of the rail line north-east of Sydenham Station. A small strip of planted native trees (including <i>Casuarina</i> spp and <i>Eucalyptus</i> spp) adjoins the northern edge of the rail line in the centre of the northern portion of the site. Given the long history of disturbance on the site, it is likely that all vegetated areas are highly modified, with low native flora biodiversity values. The site appears to contain minimal habitat values for fauna due the disturbed nature of the site including urban development, adjacent rail line and lack of vegetation. The strip of native trees would provide limited foraging habitat and shelter for fauna species. Potential microbat roosting habitat was identified in Bedwin Road overbridge, located 30 metres to the east of the site. Warehouses and industrial buildings adjoining the rail corridor to the north did not appear to support potential microbat roosting habitat, however, microbats could possibly roost within two large warehouses on Sydney Steel Road. Microbats could gain access to these warehouses via visible gaps below the roof. Existing culverts beneath the site could offer additional microbat roosting habitat.

20.3.3 Terrestrial flora

Native vegetation

All vegetation identified within the study area is mapped as Urban – Exotic / Native in *Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area* (Department of Environment, Climate Change and Water, 2009a) and field assessment has confirmed that most vegetation is planted or exotic regrowth. None of the vegetation identified in the study area falls within the description for any Plant Community Types listed in the NSW Vegetation Information System database.

No native vegetation communities were observed during site inspections, and none of the vegetation in the study area meets the criteria for any threatened ecological community listed under the EPBC Act or the TSC Act. The closest threatened ecological community mapped by the Office of Environment and Heritage (Department of Environment, Climate Change and Water, 2009a) is Blue Gum High Forest (Critically Endangered under the TSC Act and EPBC Act), which occurs in some fragmented patches about 250 metres west of the Chatswood dive site.

Terrestrial threatened flora species

No threatened flora species were recorded. Given the low native flora habitat values of the study area, there is a low likelihood of any occurring, with the exception of planted non-local native specimens.

20.3.4 Terrestrial threatened fauna species

The Protected Matters Search Tool identified 59 threatened fauna species and 78 migratory fauna species listed under the EPBC Act that are known or likely to occur within ten kilometres of the biodiversity study area. A search of the NSW Wildlife Atlas found records of 51 threatened fauna species that are known or likely to occur within ten kilometres of the biodiversity study area (refer to Technical paper 9 – Biodiversity).

The following threatened species have at least a moderate likelihood of occurrence within the biodiversity study area:

- The Grey-headed Flying-fox (*Pteropus poliocephalus*). This is a vulnerable species under the TSC Act and EPBC Act. It is found in urban gardens and feeds on the fruit of rainforest trees and vines. Fig trees at Chatswood and in the Barangaroo road reserve would provide a foraging resource for this species. As such, it has a high likelihood of occurrence at Chatswood and in the Barangaroo road reserve. The species has a moderate likelihood of occurrence at Central Station. It is unlikely to occur at the other project sites
- The Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*). This is listed as Vulnerable under the TSC Act. It occurs along the east coast of Australia. The species forages in forested areas and primarily roosts in caves, but also uses a range of built structures (Churchill, 1998). There are 82 records of the Eastern Bent-wing Bat within ten kilometres of the biodiversity study area. Buildings at Sydenham, Chatswood and Waterloo, and crevices within two bridges within the rail corridor adjacent to the Chatswood dive site, may provide roosting habitat for the species outside the birthing period, though they are within a highly modified environment subject to high levels of disturbance (such as noise), and are therefore suboptimal for this species. The species has a moderate likelihood of occurrence within the Chatswood, Central, Waterloo and Marrickville dive site
- The Eastern Freetail Bat (*Mormopterus norfolkensis*). This is listed as Vulnerable under the TSC Act. It is found east of the Great Dividing Range, from Brisbane to Sydney, where it is most commonly recorded in dry eucalypt forest and woodland, where it shows a preference for open spaces in forests. The Eastern Freetail Bat forages in openings and gaps in the forest including over larger waterways (Churchill, 1998). The species roosts mainly in tree hollows but will also roost under exfoliating bark or in built structures (Churchill, 1998). There are ten records of the Eastern Freetail Bat within ten kilometres of the biodiversity study area. Buildings at several sites and bridges at Chatswood, and hollow-bearing trees in Chatswood, may provide roosting habitat for the species, though they are within a highly modified environment subject to high levels of disturbance (such as noise), and are therefore suboptimal for this species. The species has a moderate likelihood of occurrence at Chatswood, Waterloo, Central Station and Marrickville dive sites
- The Southern Right Whale (*Eubalaena australis*). This is listed as Endangered under the TSC Act and EPBC Act. These whales migrate between summer feeding grounds in Antarctica and winter breeding grounds around the coasts of southern Australia, New Zealand, South Africa and South America. They move inshore in winter for calving and mating. Calving females and females with young usually remain very close to the coast, particularly in the five to ten metre watermark. There are eight records of the Southern Right Whale within ten kilometres of the biodiversity study areas and the species has been recorded in Sydney Harbour near Blues Point, most likely as a vagrant. Therefore the species has a moderate likelihood of occurrence in Sydney Harbour.

20.3.5 Aquatic ecology

Aquatic flora

Expansive seagrass meadows are not known to occur between Walsh Bay and Lavender Bay within the project area, however small isolated and fragmented patches of *Zostera capricorni* have been identified on the western and northern parts of Lavender Bay and in the north-west of Berry's Bay (Department of Primary Industries, 2005). Seagrasses are unlikely to be located away from the intertidal or shallow subtidal zones in the harbour due to the deep and turbid waters which limit light available for photosynthesis. Only in the clearest waters can seagrasses grow to a depth of 12 metres (Department of Primary Industries, 2007).

Other aquatic macrophytes (saltmarsh, mangroves) are not known to occur within or near the project area. Kelp (*Ecklonia radiata*) and other algae are commonly found in the shallow subtidal areas within the Harbour, including Berrys Bay, Lavender Bay and Walsh Bay.

Lavender Bay near the southernmost tip of McMahons Point is designated as a Wetlands Protection Area in the *Sydney Harbour Regional Environmental Plan (Sydney Harbour Catchment) 2005*.

Benthic fauna

The sediments within the project area provide habitat for benthic infauna and epifauna. Benthic fauna occupying nearby areas of Berry's Bay and Barangaroo include sponges, ascidians, polychaete worms, amphipods, crustaceans, cnidarians, brittle stars, bivalves and gastropods (Worley Parsons, 2010; Marine Pollution Research, 2014).

Sediment samples of the seabed were collected in the area of the two proposed grout zones. The samples were lacking in living biota with only one living bivalve and one sea pen observed.

Threatened benthic infauna or epifauna are not known to occur in the area.

Threatened aquatic mobile fauna

The Black Rockcod is listed as a vulnerable species under the FM Act. The Black Rockcod is a reef dwelling species found along the NSW coastline. They inhabit caves, gutters, beneath bommies in near shore environments to depths of 50 metres (Department of Primary Industries, 2012). Large juveniles can be found around rocky shores in estuaries. The proposed works is not expected to directly impact suitable habitat for the Black Rockcod, however the nearshore environments could provide suitable habitat.

Sharks and marine birds and mammals are also known to occur in the area, including Bull Sharks, Little Penguins and dolphins. The Little Penguin population at North Head is listed as an Endangered Population under the TSC Act. Little penguins are often observed feeding throughout the harbour.

Pipefish and seahorses (*Syngnathids*) are protected under the FM Act and most species are listed marine species under the EPBC Act. Along coasts, *Syngnathids* are commonly found near algae, weed or seagrass habitats or around man-made structures (eg jetties). Suitable habitat is not known to occur in the biodiversity study area.

20.3.6 Groundwater dependent ecosystems

A search of the National Atlas of Groundwater Dependent Ecosystems (BOM, 2015) did not identify any Groundwater Dependent Ecosystems within the study area.

The section of the study area between Central and Sydenham (ie the Central Station, Waterloo Station and Marrickville dive site) is within land that forms part of the Botany Sands Groundwater Source, and is subject to the provisions of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. The Botany Sands Groundwater Source extends to the Botany Wetlands, which include high priority groundwater dependent ecosystem listed on Schedule 4 of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*.

20.3.7 Noxious weeds and pests

Fifteen of the 51 exotic species recorded in the study area are declared noxious under the NW Act for either the Willoughby, Sydney and / or Marrickville local government areas. The NW Act imposes obligations on occupiers of land to control noxious weeds declared for their area.

The listed pest algal species, *Caulerpa taxifolia*, is not known to occur in the project area or in nearby Berrys Bay and at the Barangaroo development however marine pests could be transported from other locations. NSW Department of Primary Industries is involved in the development of the National System for the Prevention and Management of Marine Pest Incursions which aims to prevent the introduction and translocation of introduced marine species.

20.4 Assessment of potential impacts

20.4.1 Construction

Key threatening processes

The project may result in the operation of key threatening processes or the exacerbation of a key threatening process currently in operation in the study area. Key threatening processes are listed under the TSC Act and EPBC Act, and are generally defined as processes that adversely affect threatened species, populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened. Table 20-4 outlines the Key Threatening Processes which have been considered with regard to the project.

Table 20-4 Key threatening processes

Act	Key Threatening Process	Applicability to project
TSC Act	Loss of hollow-bearing trees.	Up to two hollow-bearing trees would be removed for the project.
TSC Act	Invasion and establishment of exotic vines and scramblers	Numerous exotic vines were recorded in the study area, particularly in the rail corridor within the Chatswood dive site. Species recorded within this area that are listed under the key threatening process include <i>Anredera cordifolia</i> (Madeira Vine), <i>Asparagus aethiopicus</i> (Ground Asparagus), <i>Cardiospermum grandiflorum</i> (Balloon Vine), <i>Delairea odorata</i> (Cape Ivy), <i>Hedera helix</i> (English Ivy), <i>Ipomoea indica</i> (Morning Glory), <i>Lonicera japonica</i> (Honeysuckle), <i>Tradescantia fluminensis</i> (Wandering Jew) and <i>Vinca major</i> (Periwinkle). There is a potential for disturbance during works to result in further spread of these species.

Loss of native vegetation

There is minimal native vegetation in the area to be impacted. Native vegetation is limited to planted trees and shrubs and occasional scattered regeneration of common native plant species within previously disturbed areas.

Loss of fauna habitat

Clearing vegetation at the construction sites would result in the removal of fauna habitat. Planted trees and landscaped vegetation would be removed which could impact foraging habitat and shelter for fauna species. However, impacts would be to a very small amount of vegetation and would therefore be minor and generally restricted to common fauna species that inhabit urban environments. Potential removal of fig trees at Barangaroo and Chatswood could impact foraging habitat for the threatened Grey-headed Flying-fox. Up to two hollow-bearing trees could be removed at Chatswood, as well as a nest box at Chatswood, which would reduce roosting habitat / shelter.

The removal of buildings and the bridge over the rail line at Nelson Street as well as removal of buildings at Central Station, Waterloo Station and Marrickville dive site has the potential to impact roosting and nesting fauna including microbat habitat. No microbats were observed within these sites during targeted surveys, but one common microbat call was recorded in the vicinity of the Sydenham drainage pit near the Marrickville dive site. As such, there is a moderate likelihood of microbats occurring at the Chatswood dive site, Central Station site, Waterloo Station site and Marrickville dive site.

Fauna injury or death

Fauna injury or death is most likely to occur during vegetation clearing, but may also result from collisions with vehicles or construction plant, although this is highly unlikely in the highly urbanised environment of the project. The majority of fauna species recorded within the study area are highly mobile bird species. These species are likely to be able to move away from vegetation clearing activities quite readily. Any fauna inhabiting the hollows in hollow-bearing trees may be injured during tree-felling. This could potentially include hollow-dependent birds and mammals. Animals that are unable to disperse during active clearing – such as amphibians and reptiles – are also particularly susceptible to injury or death.

Impacts on threatened species

The project has the potential to impact four threatened fauna species listed under the TSC Act, two of which are also listed under the EPBC Act, as presented in Table 20-5.

Table 20-5 Impacts on threatened species

Threatened species	EPBC Act Status	TSC Act Status	Likelihood of occurrence	Impacts of proposal
Eastern Freetail Bat (<i>Mormopterus norfolkensis</i>)	N/A	Vulnerable	Moderate	Removal and / or modification of up to two hollow-bearing trees, buildings, and a bridge that could provide roosting habitat. The area to be impacted is highly disturbed and would be suboptimal due to the adjacent train lines and roads. As such, impacts would not be significant.
Eastern Bent-wing Bat (<i>Miniopterus schreibersii oceanensis</i>)	N/A	Vulnerable	Moderate	Removal and / or modification of buildings and a bridge that could provide roosting habitat. The area to be impacted is highly disturbed and would be suboptimal due to the adjacent train lines and roads. As such, impacts would not be significant.
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	Vulnerable	Vulnerable	High	Removal of planted fig trees that provide potential foraging habitat at Barangaroo and Chatswood. Impacts are not likely to be significant due to the small amount of potential habitat to be removed.
Southern Right Whale (<i>Eubalaena australis</i>)	Endangered	Endangered	Moderate	Impacts to Southern Right Whale could occur as a result of temporary disturbance for ground improvement work in Sydney Harbour. Impacts to this species are not likely to be significant due to the low likelihood of the species being injured or disturbed as a result of the proposed works.

Assessment of significance

No threatened species are likely to be significantly impacted by the project. The findings of the EPBC Act assessments of significance are summarised in Table 20-6.

Table 20-6 Assessment of significance – EPBC Act

Threatened species of communities	Important population ¹	Likely significant impact?
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	No	No
Southern Right Whale (<i>Eubalaena australis</i>)	No	No

¹ Important population as determined by the Environment Protection and Biodiversity Conservation Act 1999, is one that for a vulnerable species:

- a) is likely to be key source populations either for breeding or dispersal
- b) is likely to be necessary for maintaining genetic diversity
- c) is at or near the limit of the species range.

Impacts to aquatic habitats

The potential impacts to aquatic habitats in Sydney Harbour from the proposed ground improvement work include:

- Direct physical disturbance to benthic habitat. The proposed grouting of unconsolidated sediments and potential anchoring of the barges would have a direct impact to the benthic infauna and epifauna. However these are shortlived, abundant taxa which are widespread throughout Sydney Harbour. Displaced taxa can readily colonise neighbouring areas due to the abundance of similar habitat. The proposed activities would not significantly impact any species, populations or communities. No threatened benthic taxa are known to occur in the project area
- Noise and vibration disturbances to mobile aquatic fauna. Noise and vibration are expected over the duration of the works. Sydney Harbour is a busy, highly used waterway with many boating and development activities. Mobile fauna have the ability to relocate during the works. The impact from the presence of barges and construction works is likely to be negligible
- Water quality impacts, including potential spills for plant and machinery, are addressed in Chapter 18 (Soils, contamination and water quality)

Mobilisation and release of sediment contaminants. The mobilisation of contaminants can potentially increase contaminant concentrations in filters feeders and benthic foragers. Activities resulting in sediment resuspension in contaminated environments in NSW Harbours has been shown to increase metal accumulation in the Sydney Rock Oyster (*Saccostrea glomerata*) by increasing water column contaminants (Hedge et al, 2009). The Department of Primary Industries (Fisheries) currently advises that no fish or crustaceans should be consumed if captured west of the Sydney Harbour Bridge due to elevated levels of dioxins.

Sediment analysis carried out has identified that lead and mercury from within the footprints are readily bioavailable while mercury is less bio-available. Laboratory elutriation tests simulating resuspension of sediment in ambient seawater carried out on sediment samples within the two grout zones demonstrated that trace metals and all organic contaminants are likely to remain bound to sediment particles and would not be released into the water column

- Spread of marine pests (particularly the marine alga *Caulerpa taxifolia*) from the transportation of plant and machinery in the harbour (eg barges). *C. taxifolia* is not known to occur in the project area. A mitigation measure (see Table 20-8) would be in place to avoid transportation of marine pests from other locations, therefore no impact is expected.

Impacts to Groundwater Dependent Ecosystems

At Waterloo Station, there is around four metres of sand near ground surface. The sand layer forms part of the Botany Sands Groundwater Source. Waterloo Station would be tanked and therefore the sand layer would be hydraulically isolated (via permanent lining) from the station shaft, by design. As such, there would be no hydraulic connection between the project and the Botany Sands Groundwater Source and thereby no impact to the Botany Wetlands groundwater dependent ecosystem.

20.4.2 Operation

Mortality of fauna species

Fauna injury or death may result from collisions with trains. However, the metro network would operate within urban areas or underground, where it is unlikely many fauna species, including threatened species, occur.

20.5 Assessment according to the Framework for Biodiversity Assessment

The NSW Biodiversity Offsets Policy for Major Projects, which clarifies, standardises and improves biodiversity offsetting for major project approvals, is underpinned by the Framework for Biodiversity Assessment (FBA). The FBA sets out the process for:

- Assessing biodiversity impacts on a proposed development site
- Determining the biodiversity offset requirements for those impacts.

An assessment of the project under the FBA has been carried out to determine whether biodiversity offsets would be required (refer to the following sections following the FBA process). It was concluded that the impacts of the project on native vegetation do not require an offset, given that the project comprises planted or highly modified native vegetation.

20.5.1 Landscape features

The FBA requires the assessment of landscape features to help describe the biodiversity values of the study area and assess the impacts of the project. Landscape features relevant to the FBA calculations summarised in Table 20-7. The project is a linear shaped development; as such, the landscape value has been assessed in accordance with the methodology in Appendix 5 of the FBA (Office of Environment and Heritage, 2014).

Table 20-7 Landscape features

Landscape feature	Study area
Interim Biogeographic Regionalisation for Australia bioregions and subregions	The study area is located within the Sydney Basin Bioregion and the Cumberland and Pittwater Subregions classified under Interim Biogeographic Regionalisation for Australia.
Mitchell landscapes	The study area intersects the Pennant Hills Ridges, Port Jackson Basin, Ashfield Plains and Sydney – Newcastle Barriers and Beaches Mitchell Landscapes.
Rivers, streams and estuaries	The study area intersects the estuary of Sydney Harbour, however the project impacts would largely be beneath the harbour bed.
Wetlands	The project site does not contain any important wetlands as defined in the FBA. Lavender Bay near the southernmost tip of McMahons Point is designated as a Wetlands Protection Area in the <i>Sydney Harbour Regional Environmental Plan (Sydney Harbour Catchment) 2005</i> .
Native vegetation extent in landscape buffer	<p>A landscape buffer of 550 metres was applied to the centre line of the study area, in accordance with the methodology for assessing landscape value for linear shaped developments of multiple fragmentation impacts in Appendix 5 of the FBA. The landscape buffer of 550 metres results in a buffer area of about 1985 ha.</p> <p>The current percent native vegetation cover in the 550 metre landscape buffer is approximately 10 per cent (192.24 ha out of the 1985 ha buffer).</p> <p>Of this 192.24 ha, only 7.82 ha has been defined as a natural vegetation community in the Department of Environment, Climate Change and Water (2009a) mapping, with the remaining 184.42 ha mapped as “Urban Exotic / Native”.</p> <p>This estimate of native vegetation extent includes planted and / or exotic vegetation cover and is different to the definition of native vegetation applied in offset calculations.</p>

Landscape feature	Study area
Score for percent current extent of native vegetation cover	The score for six to 10 per cent native vegetation in the landscape buffer is 1.25.
Future native vegetation extent in the landscape buffer	The project will impact on up to 1.63 ha of mapped Urban Exotic/Native vegetation. This would result in a negligible reduction in the percent native vegetation cover in the landscape buffer, which would remain at about 10 per cent.
Score for percent current extent of native vegetation cover	The score for future native vegetation in the landscape buffer would remain at 1.25.
Connectivity value	<p>A connecting link is identified where native vegetation on the site adjoins native vegetation surrounding the site and the native vegetation is in moderate to good condition, has a patch size >1 ha, is separated by distance of <100 metres (or <30 metres for non-woody ecosystems) and is not separated by a hostile barrier such as a large water body or dual carriageway.</p> <p>Based on the above definition, there are no connecting links within or adjoining the study area. The vegetation adjoining the rail corridor on the Chatswood dive site does not meet the criteria as it is planted native and exotic vegetation with an exotic dominated understorey, and is not in moderate / good condition.</p> <p>The definition of a state significant biodiversity link includes a riparian buffer 50 metre around an important wetland or an estuarine area. The project crosses Sydney Harbour and there would be minor impacts within the harbour and in adjacent cleared land at Blues Point. However these impacts are not within a vegetated riparian buffer and are not considered to impact on connectivity in areas adjoining the harbour.</p>
Patch size	N/A – as discussed, there is no native vegetation in moderate / good condition to be impacted by the project.
Area to perimeter ratio	N/A – no patches of native vegetation would be impacted by the project.
Landscape value score	The landscape value score for the site is 1.25.

20.5.2 Native vegetation

All vegetation identified within the study area is mapped as Urban – Exotic / Native by Department of Environment, Climate Change and Water (2009a) and field assessment has confirmed that most vegetation is planted or exotic regrowth.

None of the vegetation identified in the study area falls within the description for any Plant Community Types listed in the NSW Vegetation Information System database. Given that no Plant Community Types listed in the NSW Vegetation Information System Database are located within the study sites, it was not possible to carry out an assessment for native vegetation using the FBA credit calculator.

20.5.3 Threatened species

Ecosystem credit species

There are no Plant Community Types within the project, as such, no vegetation zones could be entered into the credit calculator and therefore a list of candidate ecosystem species for the project could not be generated. The threatened species identified in database searches were reviewed in the Threatened Species Profile Database and the credit class applicable to each species was determined (refer to Technical paper 9 – Biodiversity).

Of the 82 threatened fauna species identified, 32 are associated with ecosystem credits and six were identified as both ecosystem and species credit species in the Threatened Species Profile Database. Species credits apply to breeding habitat and ecosystem credits apply to foraging habitat for these species.

Two species associated with ecosystem credits were considered to have a moderate or high likelihood of occurrence in some parts of the study area: Grey-headed Flying-fox (*Pteropus poliocephalus*) and Eastern Freetail-bat (*Mormopterus norfolkensis*). These species are discussed in Section 20.3.4 and impacts from the project are considered in Section 20.4.

Species credit species

Thirty-one threatened fauna species identified in database searches are associated with species credits in the Threatened Species Profile Database. All threatened flora species are associated with species credits.

No threatened species associated with species credits, or their habitats, were identified in the study area.

The Office of Environment and Heritage identified two threatened flora species requiring further consideration and provision of the information specified in section 9.2 of the FBA:

- *Hibbertia* sp. Turramurra
- *Genoplesium baueri*.

20.5.4 Project impacts

Impacts on biodiversity that require further consideration

Section 9.2 of the FBA addresses biodiversity impacts that require further consideration. These are impacts that are considered to be complicated or severe, and require further consideration by the consent authority.

Under section 9.2.5 of the FBA, further consideration is required within the assessment of the effects of a development on a threatened species or population that is specifically nominated in the Secretary's environmental assessment requirements as a species or population that is likely to become extinct or have its viability significantly reduced in the Interim Biogeographic Regionalisation for Australia subregion if it is impacted on by the development. The Office of Environment and Heritage nominated two threatened species in the Secretary's environmental assessment requirements as requiring further consideration under section 9.2: *Hibbertia* sp. Turramurra and *Genoplesium baueri*.

***Hibbertia* sp. Turramurra (Julian’s *Hibbertia*)**

Hibbertia sp. Turramurra (syn. *Hibbertia spanantha*) is a decumbent shrublet up to 30 centimetres high with linear leaves about six millimetres long and bright yellow flowers approximately 20 millimetres wide. *Hibbertia* sp. Turramurra is listed as critically endangered under the TSC Act. The species was discovered in 2007 and is currently known from three locations in the northern Sydney suburbs of Turramurra, North Ryde and Cheltenham. In total, there are fewer than 20 plants occurring in the three known locations (NSW Scientific Committee 2015).

Due to the sensitive nature of the species, the exact locations of known records cannot be identified. However the three suburbs named are not in the vicinity of the project area, with the closest being North Ryde, approximately 2.5 kilometres west of the Chatswood dive site. It is therefore assumed that there are no known records of the species within or adjacent to the areas to be impacted by the project.

Habitat for the species is native forest with canopy species including *Eucalyptus pilularis*, *E. resinifera*, *Corymbia gummifera* and *Angophora costata*. The understorey is open with species of Poaceae, Orchidaceae, Fabaceae and Liliaceae. The known locations of *Hibbertia* sp. Turramurra are in close proximity to urban areas (NSW Scientific Committee 2015).

The vegetation recorded in the study area is fragmented and highly modified, and consists of planted native and exotic species or mostly exotic regrowth. No areas of suitable potential habitat for *Hibbertia* sp. Turramurra were identified.

***Genoplesium baueri* (Bauer’s Midge Orchid)**

Genoplesium baueri is a terrestrial orchid six to 15 centimetres high, fleshy, brittle, yellowish green or reddish, with a sparse inflorescence of one to three centimetres in length, bearing one to six flowers. *Genoplesium baueri* is listed as Endangered under the TSC Act and EPBC Act. The species generally occurs in coastal areas, and its range extends from Ulladulla to Port Stephens. There are a number of older records of the *Genoplesium baueri* from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga; no collections have been made from these locations in recent years.

There are 11 records of *Genoplesium baueri* in the NSW Bionet Wildlife Atlas within 10 kilometres of the study area; 10 of the records are dated between 1881 and 1918. There is one record dated from 2011, located approximately 7.5 kilometres to the west of the Chatswood dive site.

Habitat for *Genoplesium baueri* is variously described as dry sclerophyll forest and moss gardens over sandstone (OEH 2016, NSW Flora Online) and heathland to shrubby woodland on sands or sandy loams or open forest, shrubby forest and heathy forest on well-drained sandy and gravelly soils (NSW Scientific Committee 2012). Plants do not regularly appear aboveground every year, and individual plants may remain dormant in the soil. Flowering is between December and April and it has been suggested that flowering is enhanced by summer fires (NSW Scientific Committee 2014).

The vegetation recorded in the study area is fragmented and highly modified, and consists of planted native and exotic species or mostly exotic regrowth. No areas of suitable potential habitat for *Genoplesium baueri* were identified.

Neither *Hibbertia* sp. Turramurra nor *Genoplesium baueri* was recorded in the study area, and no potential habitat for the species was identified during surveys. Given the poor native flora habitat values and lack of nearby records of the species nominated for further consideration, it is considered unlikely that these species or their habitat would occur in the study area or adjacent areas, and therefore they would not be impacted by the project.

Impacts not requiring assessment or offset determination

An assessor is not required to assess areas of land on a development site without native vegetation, unless the Secretary's environmental assessment requirements issued for the project specifically require it.

The project site largely contains highly modified vegetation that does not comprise native vegetation within the meaning of the FBA. These areas contain no or very little native overstorey or midstorey vegetation and are dominated by exotic ground cover. Much of this vegetation occurs on cuttings or fill associated with unnatural landforms.

The project site also includes buildings, hardstand areas and other infrastructure with occasional planted vegetation that do not comprise native vegetation within the meaning of the FBA and do not require further assessment.

20.5.5 Environmental values not assessed under the FBA

Biodiversity values not considered under the FBA include:

- Marine mammals
- Wandering sea birds
- Biodiversity that is endemic to Lord Howe Island.

There is potential for marine mammals to occur within Sydney Harbour, in the vicinity of the proposed ground improvement work.

Marine mammals recorded in Sydney Harbour include Southern Right Whale and Humpback Whale, Dwarf Minke Whale, Common Dolphin, Bottlenose Dolphin, Spotted Dolphin, New Zealand Fur-seal, Australian Fur-seal, Australian Sea-lion, Leopard Seal and Southern Elephant Seal. Of these species, only Southern Right Whale, Common Dolphin, Bottlenose Dolphin, New Zealand Fur-seal, Australian Fur-seal and Leopard Seal have been recorded in the vicinity of the proposed works; all other records are closer to the heads in the outer harbour.

The ground improvement work would be conducted from barges located to the west of Sydney Harbour Bridge. Potential impacts to marine mammals from the proposed work could include increased collision risk, stress or disturbance to navigation from noise impacts, and water quality impacts. Given the low frequency and density at which marine mammals occur in Sydney Harbour, and the existing harbour traffic, it is considered unlikely that any marine mammals would be adversely affected as a result of the proposed work.

In addition, the FBA does not assess the direct impacts of a project that are not associated with clearing of vegetation. Examples of such impacts referenced in the FBA that although highly unlikely to occur may be relevant to the current project include:

- Vehicle strike
- Downstream impacts on hydrology and environmental flows on surface vegetation and groundwater dependent ecosystems.

These types of impacts are assessed in Section 20.4 of this document.

20.6 Mitigation measures

The mitigation measures that would be implemented to address potential biodiversity impacts are listed in Table 20-8.

Table 20-8 Mitigation measures – biodiversity – construction

Ref	Mitigation measure	Applicable location(s) ¹
B1	An ecologist would be present during the removal of any hollow-bearing trees.	CDS
B2	Potential bat roosting locations at Central Station, Waterloo Station and Marrickville dive sites would be checked by a qualified ecologist or wildlife handler prior to demolition. Any bats found would be relocated.	CS, WS, MDS
B3	The local WIRES group and / or veterinarian would be contacted if any fauna are injured on site or require capture and / or relocation.	All except metro rail tunnels
B4	Procedures would be developed and implemented, in accordance with the National System for the Prevention and Management of Marine Pest Incursions, during Sydney Harbour ground improvement works to avoid transportation of marine pests from other locations, particularly the marine alga <i>Caulerpa taxifoli</i> .	GI

¹ STW: Surface track works; CDS: Chatswood dive site; AS: Artarmon substation; CN: Crows Nest Station; VC: Victoria Cross Station; BP: Blues Point temporary site; GI: Ground improvement works; BN: Barangaroo Station; MP: Martin Place Station; PS: Pitt Street Station; CS: Central Station; WS: Waterloo Station; MDS: Marrickville dive site; Metro rail tunnels: Metro rail tunnels not related to other sites (eg TBM works); PSR: Power supply routes.