Appendix B – Environmental Assessment – Southern Sydney Protection Zone

Environmental Assessment Southern Sydney Protection Zone

Introduction

The proposed APX-East Submarine Cable Project (APX-East) is a trans-pacific fibre-optic telecommunications cable, which extends from Sydney, Australia to California, United States of America. This report has been collated to provide information in support of project approvals for the portion of the cable corridor that will be located only in the Southern Sydney Protection Zone (SSPZ).

The purpose of this report is to describe the habitats and values of the areas relevant to the APX-East corridor within the SSPZ. Information provided in this document has been collated from a variety of sources including published scientific literature, government and scientific reports, online databases and aerial imagery. An assessment of potential impacts of the project on these values is provided in Appendix C.

The APX-East corridor will include a terrestrial cable landing area, an intertidal cable corridor, and a subtidal cable corridor. The cable corridor has a maximum width of 10 m, with the area of disturbance comprising a small portion of this area; the terrestrial cable landing area is approximately 250 m^2. The cable will be buried in the intertidal and inshore areas, until a water depth of approximately 1500 m is reached, at which point the cable will be placed on the open seabed.

The environmental values which may be directly or indirectly impacted upon by the installation and/or maintenance of APX-East include:

- Terrestrial habitats at the cable landing point
- Nearshore habitats
- Offshore habitats
- Bronte-Coogee Aquatic Reserve
- Fisheries resources
- Matters of National Environmental Significance

These values are described following.

Habitat Overview

The habitats described herein are those present within the SSPZ of the APX-East corridor. This extends from the terrestrial cable landing site at Coogee to the SSPZ boundary limit in the Coral Sea, approximately 75 km from shore. The APX-East corridor will transect or lie in proximity to a range of habitats including nearshore sandy beaches, rocky reefs, sub-tidal sand expanses and the continental slope to approximately 2000 m depth (Tyco Electronics Subsea Communications, 2013) (Figure 1).

The terrestrial cable landing site is located in the southwest corner of Dunningham Park, Coogee Beach. Dunningham Park is maintained grassy area with small trees and picnic shelters (Plate 1). The cable corridor runs underground from the landing site, under the sandy intertidal beach, to the offshore area. Within the nearshore marine environment the cable will be placed on/buried in sandy substrate only. Located nearby, but outside the cable corridor are intertidal and subtidal rocky reefs associated with the northern headland of Coogee Beach, and

the rocky outcrop known as Wedding Cake Island (Plate 1). As APX-East moves seaward, the benthic habitat will be largely dominated by open sandy expanses.

Plate 1 Photographs of Dunningham Park (top) and Coogee Beach (bottom)

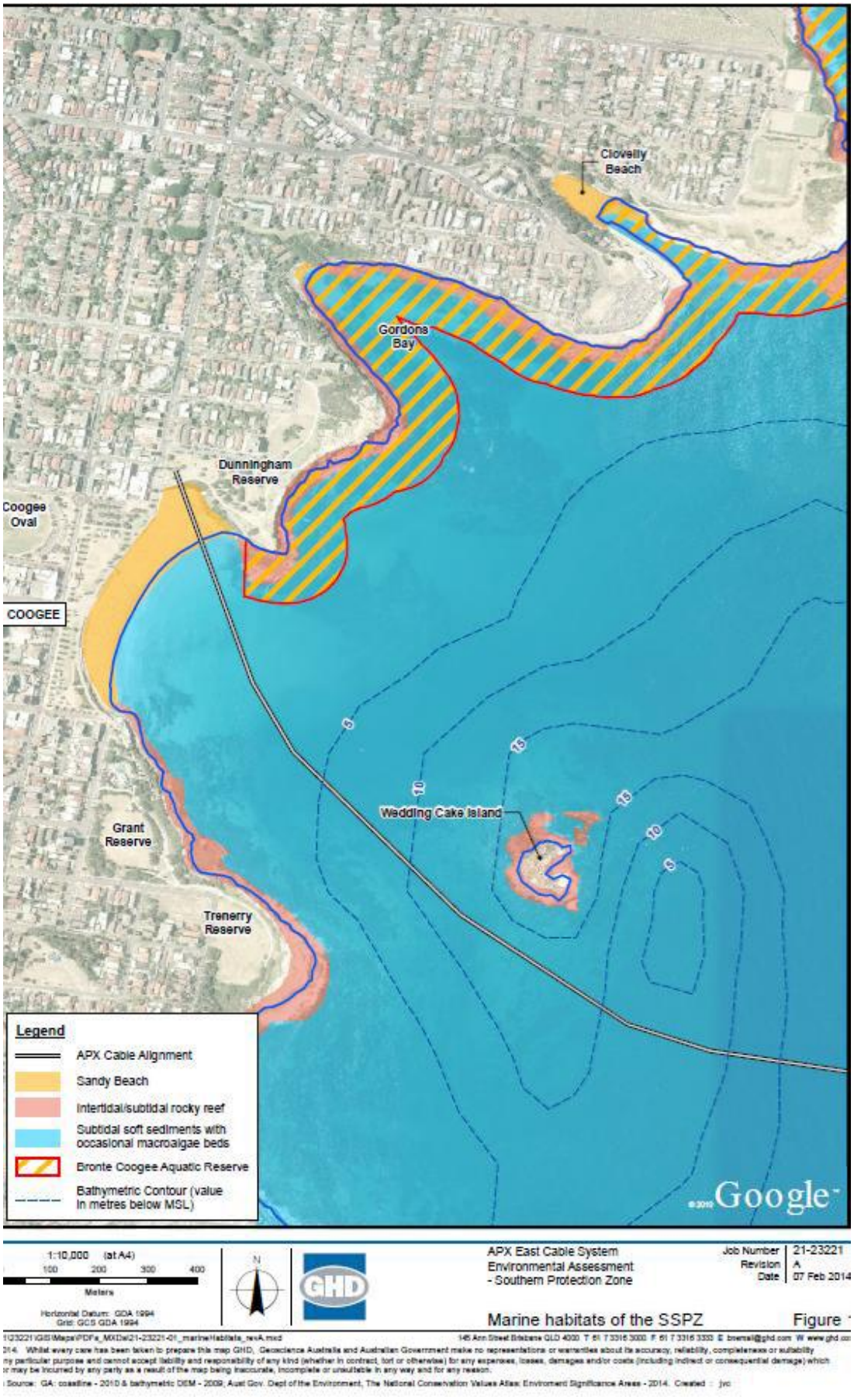

Figure 1 Marine habitats of the SSPZ

Nearshore Habitats and Associated Communities

Soft Sediments

The nearshore benthic habitats within the APX-East corridor are comprised of primarily unvegetated soft sediments, including sandy beach areas and open expanses. The high energy wave climate and mobility of the sediments of the area is not conducive to persistence of highly diverse systems. As such, these habitats primarily support limited infaunal and epifaunal invertebrate communities (Davie, 2011), and the occasional macroalgae bed. These habitats in turn support higher order transient organisms such as teleost fishes.

Infaunal organisms are those that burrow through surface sediments and include polychaete worms, sipuculids, bivalve molluscs and crustaceans. The majority of these species are not harvested for commercial use, however some species can be collected recreationally principally as fishing bait. Epifaunal assemblages found in the Sydney region include crustaceans, echinoderms and molluscs. A number of these species form part of locally targeted recreational and commercial fisheries. Such species include the blue swimmer crab (*Portunus pelagicus*), the Eastern king prawn (*Penaeus plebejus*) and the school prawn (*Metapenaeus macleayi*). These species are all highly mobile, and as such may occasionally transit in the APX-East corridor. This is further discussed in Fisheries Resources below.

Rocky Reefs

The APX-East corridor does not traverse any nearshore rocky reefs. There are however a number of nearshore subtidal and intertidal rocky reefs in proximity to the APX-East corridor, including Wedding Cake Island and the headlands of Coogee Beach (Figure 1). Whilst these areas will not be directly impacted by the project, there is potential for indirect impacts to be realised.

Temperate rocky reef habitats are known to support a diversity of species, including listed EPBC species and commercially and recreationally important marine species. Comparatively, rocky reef habitats support a higher diversity of marine fauna than sandy areas. This is due to a number of factors including the availability and higher diversity of niche habitat areas and refugia, which encourage the settlement of sessile organisms and provide shelter/resources of sedentary fauna. This in turn promotes macro-invertebrates and teleosts to recruit to these habitats (Diaz et al., 2004).

Nearshore rocky reefs in the Sydney region are known to support sponges, temperate corals, echinoderms, molluscs and crustaceans (Connell and Glasby, 1999). Recreationally and commercially relevant fishery species which inhabit these areas include snapper (*Pagrus auratus*), yellowtail kingfish (*Seriola lalandi*) and a variety of cephalopods and crustaceans.

The nearshore rocky reef environments also provide habitat suitable for protected pipe fishes (Syngnathidae). Additionally, aggregations of the critically endangered grey nurse shark (*Carcharias taurus*) are known from rocky reef areas along the New South Wales (NSW) coastline. Although major aggregations occur outside the APX-East corridor, it is possible that this species inhabits rocky reef areas in proximity to the cable and may infrequently transit through the APX-East corridor (refer to Matters of National Significance for further detail).

Macroalgal Beds

Temperate rocky reefs, such as those found in the Sydney region, are often associated with macroalgal beds. These are generally characterised by kelp (*Ecklonia radiata*) and species from the genus *Sargassum*. Macroalgal beds provide habitat for a high diversity of animals and act as nursery areas for many species. As such, they have high ecological significance within the

near shore environment (Dayton, 1985). Additionally, macroalgae can form part of the diet for marine turtles, and is therefore an important resource for these threatened species.

As the nearshore rocky reef areas are outside of the APX-East corridor, the macroalgal beds associated with these areas will not be directly impacted by the project. Small stands of macroalgae located on the open substrate may be traversed by the APX-East corridor, as such there is potential for small direct and indirect impacts to be realised. This is further addressed in the project impact assessment (refer Appendix D).

Fisheries Resources

The diversity of nearshore and offshore habitats off Sydney support a speciose fish community that is of ecological, recreational and commercial importance. Recreational fishing in the Sydney region (including fresh and salt water fishing) is thought to employ nearly 4,000 people, and generates an economic output of nearly $1.8 billion per year (McIlgom and Pepperell, 2013). Throughout coastal and offshore waters of broader NSW, the seafood industry alone generates approximately $90 million per year (Tyco Electronics Subsea Communications, 2013). Commercial marine and estuarine fishing in NSW have historically centred on a number of key species, namely:

- Snapper (*Pagrus auratus*)
- Yellowfin bream (*Acanthopagrus australis*)
- Flathead (*Platycephalus spp.*)
- King (*Melicertus spp.*) and school prawns (*Metapenaeus spp.*)
- Sea mullet (*Mugil cephalus*)
- Mulloway (*Argyrosomus japonicus*)
- Whiting (*Sillago spp.*)
- Yellowtail kingfish (*Seriola lalandi*)
- Deepwater reef fish (e.g. blue-eye trevalla (*Hyperoglyphe antarctica*))
- Eastern rock lobster (*Jasus verreauxi*)
- Crabs (NSW Department of Primary Industries, 2008)

Marine and coastal fish disperse through both active and passive movement within their lifetimes. Most species have a larval phase which can last from a few days to months, during which time larvae are moved by the tides and currents (passive dispersal) and recruit to new populations (Sheaves et al., 2007; Smith, 2003; Watts and Johnson, 2004). Larval dispersal also enables fish to quickly recolonise disturbed habitats or supplement small populations that are not self-sustaining (Barber et al., 2002; Crowder et al., 2000; Gaggiotti, 1996).

Developed fish (*i.e.* post-larval phase) actively move through their environment and are not dependent on passive dispersal (Roberts and Ayre, 2010). Consequently, developed fish are able to move away from danger, disturbance or low-quality habitat (Le Quesne and Coding, 2009). This active dispersal also allows fish to colonise areas and move in search of suitable breeding or foraging resources (Kaunda-Arara and Rose, 2004). Cable laying activities have potential to temporarily disturb fishes occurring in the direct path of activities. Given their mobility, this disturbance is not predicted to persist and it is likely that fish will quickly recolonise the disturbed area, through both larval recruitment and developed fish actively moving back to the disturbed area (Le Quesne and Coding, 2009).

Bronte-Coogee Aquatic Reserve

The NSW system of marine protected areas comprises multi-use marine parks, aquatic reserves, and national parks and reserves with marine components. The APX-East corridor is located outside, but adjacent to the Bronte-Coogee Aquatic Reserve (Figure 1). There are no other marine protected areas in proximity to the APX-East corridor.

The Bronte-Coogee Aquatic Reserve is approximately 4 km long, extending from the southern headland at Bronte Beach to the rock baths at the northern headland of Coogee Beach. Within the reserve, waters extending 100 m from the shore are protected from a number of harvesting activities, including the collection of invertebrates and blue grouper (Office of Environment and Heritage, 2014).

Benthic habitats in this reserve consist primarily of temperate rocky reefs interspersed with sandy habitats. These support macroalgal beds, cunjevoi communities and sponges as well as a diverse range of other marine taxa including macro-invertebrates, teleosts, cephalopods and elasmobranchs. There are a number of commercially and recreationally important marine species within the reserve, including abalone, octopus, blue grouper and other teleosts (Office of Environment and Heritage, 2014).

This reserve will not be directly impacted by the project and given the distance to project works it is unlikely that indirect impacts to the habitats within the reserve will occur. However, any release of pollutants or contaminants during projects works have potential to affect this area. This is further addressed in the project impact assessment (refer Appendix D).

Offshore Habitats

Continental Shelf and Slopes

The proposed APX-East corridor runs from Coogee Beach out to the continental shelf margin. The offshore environment within the SSPZ is influenced by a number of oceanographic features. Seasonally, the southward flowing eastern Australian current brings warm water to the region, particularly in summer months (Ridgway, 2007). Additionally, upwelling events take place along the Sydney coastline, bringing nutrient rich waters to the area. The interactions between these two events add to the dynamics of the region, increasing productivity and diversity of marine fauna. Offshore waters of the SSPZ are primarily comprised of open sandy systems but occasionally support rocky reefs.

Similar to nearshore rocky reefs environments, the offshore rocky reef communities comprise macroinvertebrate colonies on rocky reefs that support demersal and semi-pelagic fishes, which in turn can support marine mammals and predatory fishes. The diversity of benthic organisms within offshore habitats can remain relatively high, with a general reduction in biomass and species richness occurring as depth increases (Currie and Sorokon, 2014).

Soft sediments are likely to be the dominant benthic habitat for the majority of the APX-East corridor within the SSPZ. As with nearshore areas, offshore sand habitats support sparsely distributed infaunal and epifaunal invertebrates, as well as benthic associated fishes and molluscs.

Matters of National Environmental Significance

The following provides an assessment of matters of National Environmental Significance (NES) relevant to the APX-East corridor within the SSPZ. The Protected Matters Search Tool (PMST) identifies matters of NES and other matters protected under the EPBC Act that are predicted to occur in, or relate to a defined area. This tool was utilised to search the APX-East corridor within

the SSPZ, including a 10 km buffer area. The resulting Protected Matters Report identified the following relevant matters:

- 4 world heritage properties
- 10 national heritage properties
- 1 wetland of international importance
- 1 Commonwealth Marine Area
- 1 Commonwealth Marine Region
- 2 threatened ecological communities
- 67 threatened species
- 77 migratory species

Further details for each of these matters, including proximity to the project and potential for impact to be realised, are provided in the following sections. The output of the Protected Matters Search Tool is provided in Appendix A.

World Heritage

The APX-East corridor does not lie within the boundaries of any world heritage property (Figure 2). Four land-based world heritage areas were identified within the Protected Matters search 10 km buffer area. These include the Hyde Park Barracks and associated buffer zone, and the Sydney Opera House and associated buffer zone, which are located 7 km and 8 km from the project, respectively. Given the distance and lack of environmental relationship between these locations and the cable corridor, the project will not impact any of these world heritage properties.

National Heritage

The APX-East corrido does not lie within the boundaries of any national heritage property (Figure 2). Ten national heritage areas were identified within the Protected Matters search 10 km buffer area, including one of Indigenous significance, the Cyprus Hellene Club – Australian Hall, and nine historic places:

- Bondi Beach
- First Government House site
- Hyde Park Barracks
- Kurnell Peninsula Headland
- Sydney Harbour Bridge
- Sydney Opera House
- Colonial Sydney
- Kamay Botany Bay
- Bondi Surf Pavilion

Given the distance and lack of environmental relationship between these locations and the cable corridor, these national heritage areas will not be impacted by the project.

Wetlands of International Importance

The APX-East corridor does not lie within the boundaries of any wetlands of international importance (Figure 2). One Ramsar Convention listed wetland was identified within the

Protected Matters search 10 km buffer area. The Towra Point Nature Reserve is located 13.5 km to the south of the project. Given the distance and lack of environmental relationship between these locations and the cable corridor, this reserve will not be impacted by the project.

Commonwealth Marine Areas and Regions

The APX-East corridor does not lie within any Commonwealth Marine Reserve boundary, but does fall within both the Exclusive Economic Zone and the Territorial Sea, which are classed as Commonwealth Marine Areas. Under the EPBC Act Commonwealth Marine Areas are considered to be a matter of NES. To aid in the assessment of the potential impacts to Commonwealth Marine Areas, a set of key ecological features (KEFs) that are considered important for biodiversity or ecosystem function were demarcated by the Australian Government.

KEFs are designated under one or more of the following categories:

- A species, group of species or a community with a regionally important ecological role (e.g. a predator, or a prey species that interacts significantly with a large biomass or number of other marine species)
- A species, group of species or a community that is nationally or regionally important for biodiversity
- An area of habitat that is nationally or regionally important for:
  - Enhanced or high biological productivity (such as predictable upwellings)
  - Aggregation of marine life (such as feeding, resting breeding or nursery areas)
  - Biodiversity and/or endemism
- A unique seafloor feature with known or presumed ecological properties of regional significance.

The Protected Matters Search Tool did not identify any KEFs within the APX-East corridor or the 10 km buffer. This result was verified using the National Conservation Values Atlas (http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf) produced by the Department of Environment. The closest KEFs are approximately 15 km from the APX-East corridor (Figure 2). Consequently, APX-East is not predicted to impact the KEFs which define the Commonwealth Marine Area values for this section of the SSPZ.

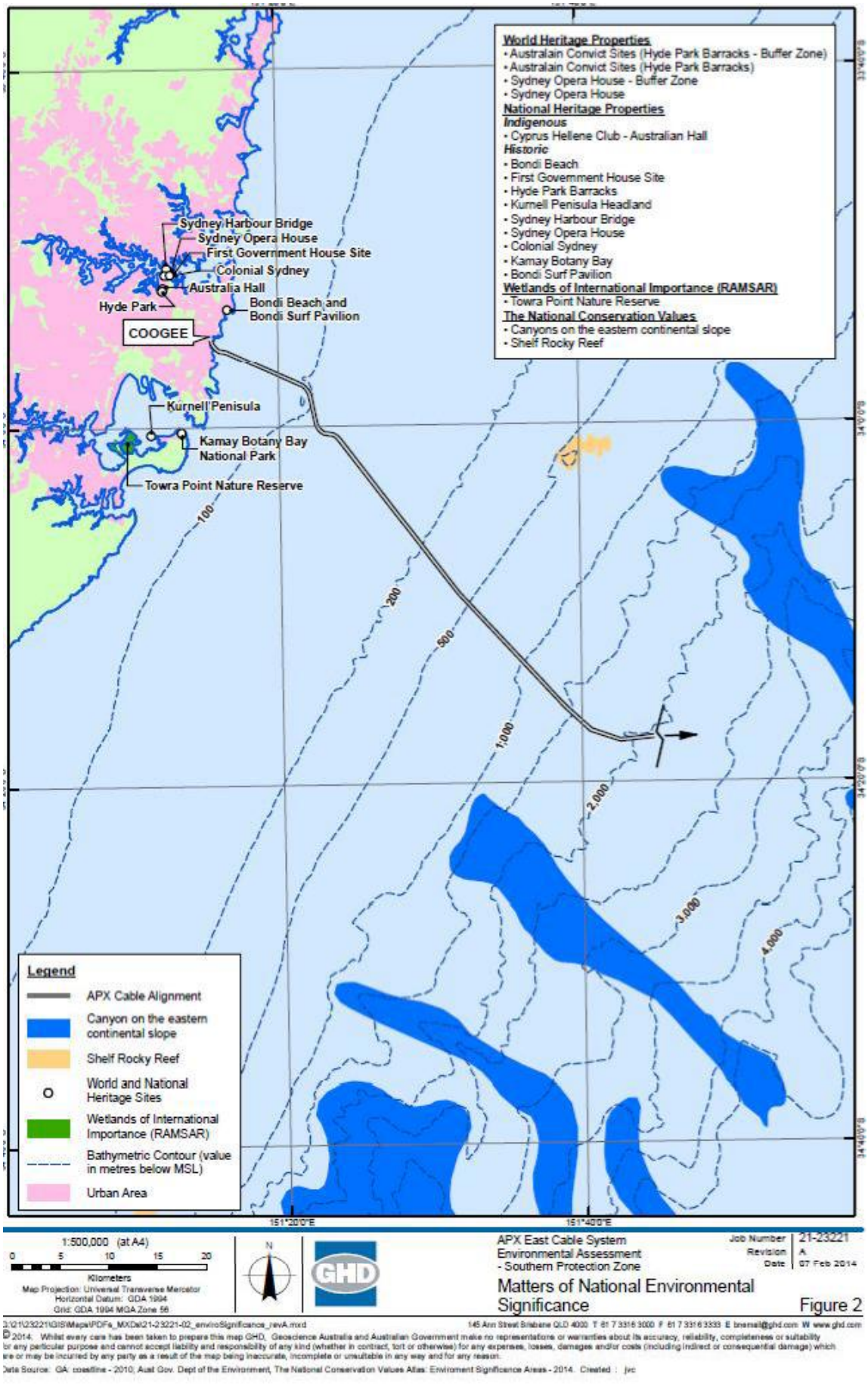

Figure 2 Matters of National Environmental Significance

Listed Threatened Ecological Communities

There are no threatened ecological communities within the APX-East corridor. Two threatened ecological communities were identified within the Protected Matters search 10 km buffer area:

- Eastern Suburbs Banksia Scrub of the Sydney Region
- Western Sydney Dry Rainforest and Moist Woodland on Shale

Eastern Suburbs Banksia Scrub of the Sydney Region is listed as 'endangered' under the EPBC Act. This threatened ecological community is characterised by sandy, nutrient poor deposits in the east and south-east suburbs of Sydney, and is typified by sclerophyllous heath or scrub with small areas of woodland or low forest (Department of the Environment, 2014a).

Western Sydney Dry Rainforest and Moist Woodland on Shale is listed as 'critically endangered' under the EPBC Act. It has a highly restricted distribution, occurring only in sheltered gullies and slopes on steep, rugged topography in the Sydney Basin bioregion. Neither of these communities occur within the project footprint and given the geographical distance and lack of ecological connectivity to these communities they are not predicted to be impacted by the project.

Listed Threatened Species

Sixty-seven threatened species were identified by the PMST as matters relevant to the APX-East corridor within the SSPZ, including:

- Three marine mammals
- Five marine reptiles
- Two fish
- Four sharks
- 19 marine birds
- 34 terrestrial species

To understand potential to impact upon these species a likelihood of occurrence ranking was attributed to each threatened species, based on the following framework:

- Unlikely to occur: species has not been recorded in the region AND/OR current known distribution does not encompass APX-East corridor AND/OR suitable habitat is generally lacking from APX-East corridor.
- May occur: mapped species' distribution incorporates APX-East corridor AND potentially suitable habitat occurs within the APX-East corridor.
- Likely to occur: species has been recorded in the region and potentially suitable habitat is present within the APX-East corridor.

Marine Mammals

Three listed marine mammal species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 1). These species are all highly mobile and are only likely to occur in the region as transient visitors during annual migrations. Table 1 provides an overview of known habitat requirements for each of the species, and a likelihood of occurrence assessment based on this information. Further information relating to the life history of each of these species (which has informed this assessment) is provided in the Threatened Species Summary Information below.

Table 1 Threatened marine mammals

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
Blue whale - pygmy blue whale (*Balaenoptera musculus brevicauda*) - southern blue whale (*Balaenoptera musculus intermedia*) - northern blue whale (*Balaenoptera musculus musculus*)	En, Mig	The project footprint is located outside the known distributions for the southern and northern sub-species (Department of the Environment, 2014b). The project footprint is also located outside the two known Australian feeding aggregations. These are found off the coast of south Western Australia, and South Australia/Victoria (Attard et al., 2010). The migratory pathways of blue whales are very poorly understood; however, it is possible that they are crossed by the APX-East corridor.	**May occur** The pygmy blue whale sub-species may transit the project footprint during annual migrations.
Southern right whale (*Eubalaena australis*)	En, Mig	The major calving areas for this species are generally restricted to waters off Western Australia, South Australia and Victoria (Department of the Environment, 2014c). The closest known calving area to the APX-East corridor is off the coast of Eden in southern NSW. No specific feeding areas have been identified for this species. The migratory pathways of this species will be crossed by the APX-East corridor.	**Likely to occur** This species is likely to transit the project footprint during annual migrations.
Humpback whale (*Megaptera novaeangliae*)	V, Mig	Along the Australian coastline humpback whales have a number of key calving, migration and resting areas (Department of the Environment, 2014d). In eastern Australia, most calves are born in the Great Barrier Reef region. However, calving also take place along the migratory pathways, including off the coast of Sydney. The migratory pathways of this species will be crossed by the APX-East corridor.	**Likely to occur** This species is likely to transit the project footprint during annual migrations.

Notes: En: Endangered, V: Vulnerable, Mig: Migratory

Marine Reptiles

Five listed marine reptile species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 2). These species are all highly mobile and are only likely to occur in the region as transient visitors whilst travelling between food sources. The APX-East corridor is not considered to be core habitat for any of these species. Table 2 provides an overview of known habitat requirements for each of the species, and a likelihood of occurrence assessment based on this information. Further information relating to the life history of each of these species (which has informed this assessment) is provided in the Threatened Species Summary Information below.

Table 2 Threatened marine reptiles

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
Loggerhead turtle (*Caretta caretta*)	En, Mig	Widely distributed throughout Australian coastal and offshore zones (Department of the Environment, 2014e). Nesting sites for the species occur throughout northern Australia from southern Queensland through to Shark Bay in WA (Limpus, 2008a). Suitable habitat includes coral reefs, rocky reefs, seagrass beds and inshore embayments. This species has been recorded feeding in the Sydney region. Suitable habitat for this species, including macroalgal beds and rocky reef outcrops occur outside of, but in proximity to the APX-East corridor.	**May occur** The APX-East corridor footprint is not considered core habitat for this species. This species may transit the area whilst travelling between food sources.
Leatherback turtle (*Dermochelys coriacea*)	En, Mig	Circum-globally distributed in warm temperate to tropical seas. The species occurs in open ocean basins, making landfall to nest at known locations including central-Queensland (Limpus, 2008b). Few records exist of the species within NSW, with a single record known from waters in proximity to the APX-East corridor (Limpus, 2008b). This species may occur in offshore waters within the APX-East corridor.	**May occur** The APX-East corridor footprint is not considered core habitat for this species. This species may occur in the area as a transient visitor.
Green turtle (*Chelonia mydas*)	V, Mig	Species is distributed throughout Australian coastal warm temperate to tropical seas.	**May occur** The APX-East

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		Nesting occurs throughout northern Australia and is not known to occur in NSW. Following hatching, neonate and juvenile turtles remain in pelagic and offshore waters until they reach approximately 30 to 40 cm carapace length (Department of the Environment, 2014f). Adults are commonly encountered in seagrass beds and in proximity to macroalgal benthic habitats. This species is known to occur in the Sydney region.	corridor footprint is not considered core habitat for this species. This species may occur in the area as a transient visitor.
Hawksbill turtle (*Eretmochelys imbricata*)	V, Mig	The species has a circum-global distribution, occupying open ocean and coastal temperate and tropical seas. More commonly encountered in rocky reef and coral reef areas where it feeds on sponges, seagrasses, soft corals and molluscs (Department of the Environment, 2014g). Known nesting grounds occur in northern Australia; nesting does not occur in NSW. Suitable habitat exists within the APX-East corridor however rocky reefs where the species is more common are located outside and adjacent to the footprint.	**May occur** The APX-East corridor footprint is not considered core habitat for this species. This species may occur in the area as a transient visitor.
Flatback turtle (*Natator depressus*)	V, Mig	The species has a restricted distribution in Australia between the Kimberley in Western Australia and Queensland's central east coast (Department of the Environment, 2014h). Only a handful of records are known from NSW (Limpus, 2008c). Suitable habitat exists within the APX-East corridor however rocky reefs where the species is more common are located outside and adjacent to the footprint.	**May occur** The APX-East corridor footprint is not considered core habitat for this species, and is considered to be outside of this species general distribution. This species may occur in the area as a transient visitor.

Notes: En: Endangered, V: Vulnerable, Mig: Migratory

Marine Fish

Two listed marine fish species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 3). The APX-East corridor is not considered to be core habitat for either of these species; suitable habitat is only present for the Australian grayling in the open coastal waters of the region. This species occurs in fast moving shoals which readily move from an area when disturbed. Table 3 provides an overview of known habitat requirements for each of the species, and a likelihood of occurrence assessment based on this information. Further information relating to the life history of each of these species (which has informed this assessment) is provided in the Threatened Species Summary Information below.

Table 3 Threatened marine fish

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
Black rockcod (*Epinephelus daemelii*)	V	The species is found throughout the south-west Pacific and demonstrates high site fidelity within rocky reefs. Part of the reason that the species has undergone decline is due to the species often occupying an individual cave for its entire life-cycle (Department of the Environment, 2014i). Suitable habitat exists within the APX-East corridor however rocky reefs where the species is more common are located outside and adjacent to the footprint.	**Unlikely to occur** Core habitat for this species is not found within the APX-East corridor footprint
Australian grayling (*Prototroctes maraena*)	V	Inhabits coastal, freshwater and brackish environments (Department of the Environment, 2014j). As adults, the species inhabits freshwater streams and pools, with the larvae and juvenile age classes inhabiting coastal and estuarine waters. The majority of threats to this species occur in the freshwater environment, including the obstruction of fish passage by artificial structures and competition from the introduced brown trout. Juveniles or larvae may occur in the coastal waters of the APX-East corridor.	**May occur** Juveniles or larvae may occur in the coastal waters of the APX-East corridor.

Notes: V: Vulnerable

Sharks

Four listed marine shark species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 4). The APX-East corridor is not considered to be core habitat for any of these species. The green sawfish is presumed extinct in NSW waters, and the three remaining species are all highly mobile and are only likely to occur in the footprint as transient visitors. Table 4 provides an overview of known habitat requirements for each of the species, and a likelihood of occurrence assessment based on this information. Further information relating to the life history of each of these species (which has informed this assessment) is provided in the Threatened Species Summary Information below.

Table 4 Threatened sharks

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
Grey nurse shark (east coast population) (*Carcharias taurus*)	CE	The species is distributed throughout Australian coastal waters, with the largest populations from sub-tropical and temperate areas throughout eastern and western Australia (Last and Stevens, 2009). In NSW waters, aggregations of the species occur at nearshore rocky outcrops including Julian Rocks at Byron Bay and Fish Rock at South West Rocks. Transient individuals or smaller aggregations may occur at the nearshore rocky reefs in proximity to the APX-East corridor.	**May occur** Core habitat for this species is not found within the APX-East corridor footprint, however individuals may transit the project footprint.
Great white shark (*Carcharodon carcharias*)	V, Mig	The shark is distributed predominantly throughout temperate Australia, with individuals known to undertake migrations into sub-tropical and tropical waters (Bruce et al., 2006). Known aggregations occur in nearshore waters of NSW, the most well-known of these occurs at Stockton Beach, Newcastle. Suitable habitat for this species occurs in the coastal waters of the APX-East corridor	**Likely to occur** This species is likely to occur in the area given the species distribution and prevalence in temperate coastal waters of Australia.
Green sawfish (*Pristis zijsron*)	V	Along the east coast of Australia, the green sawfish has undergone a large-scale range reduction in southern and central waters. The species is presumed extinct within NSW waters (NSW Department of	**Unlikely to occur** Suitable habitat for this species occurs in the region, however,

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		Primary Industries, 2013).	the species is presumed extinct in NSW.
Whale shark (*Rhincodon typus*)	V, Mig	The species is known from eastern Australia; however, it remains in low numbers along this coastline, with sightings of the species remaining rare (Last and Stevens, 2009). Offshore waters within the APX-East corridor possibly provide suitable habitat for the species. However, it is more common from subtropical and tropical waters	**May occur** This species may occur in the area as a transient visitor.

Notes: CE: Critically Endangered, V: Vulnerable, Mig: Migratory

Marine Birds

Nineteen listed marine bird species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 5). The APX-East corridor is not considered to be core habitat for any of these species, however the inshore and offshore waters may provide suitable foraging habitat. All of these species are all highly mobile and are only likely to occur in the footprint as transient visitors. Table 5 provides an overview of known habitat requirements for each of the species, and a likelihood of occurrence assessment based on this information. Further information relating to the life history of each of these species (which has informed this assessment) is provided in the Threatened Species Summary Information below.

Table 5 Threatened marine birds

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
Northern royal albatross (*Diomedea epomophora sanfordi*)	En, Mig	A migratory bird that occurs in the coastal and marine aerial habitats south of Brisbane through to Antarctica. Breeding takes place off the coast of New Zealand (Department of the Environment, 2014k). Little is known of the exact migration pathways. In a small study of three individuals Thomas et al. (2010) found that juveniles migrated directly to Chile after fledging. Offshore waters within the APX-East corridor provide suitable	**Likely to occur** This species is likely to occur in the area as a transient visitor.

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		foraging habitat for the species.	
Tristan albatross (*Diomedea exulans exulans*)	En, Mig	This species is a marine pelagic seabird. The majority of breeding takes place off the coast of South Africa in the South Atlantic Ocean. The foraging grounds of this species are off the Cape of Good Hope in the Atlantic Ocean (Department of the Environment, 2014l). There is only one record of this species within Australian waters; an individual banded in the Atlantic ocean was recorded off the coast of Wollongong NSW.	**Unlikely to occur** Core habitat for this species is not found within the APX-East corridor footprint.
Southern giant-petrel (*Macronectes giganteus*)	En, Mig	This species is widespread but generally found in low densities across landmasses in Antarctic waters in summer, and is thought to move to areas north of 50 °S in winter (Department of the Environment, 2014m). Breeding occurs on several islands in the Southern Ocean and Australian Antarctic Territory. Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**May occur** This species may occur in the area as a transient visitor.
Gould's petrel (*Pterodroma leucoptera leucoptera*)	En, Mig	Endemic to Australian waters (Department of the Environment, 2014n; O'Dwyer et al., 2007). Little is known of the movement, migration and dispersal patterns of this species; however, it is thought that during the non-breeding season, birds move to the north Tasman Sea or east Pacific Ocean (Department of the Environment, 2014n; Marchant and Higgins, 1990; Roberson and Bailey, 1991). Breeding occurs in only two areas – Cabbage Tree Island and the Boondelbah Islands, off the Newcastle coast. Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**May occur** This species may occur in the area as a transient visitor.

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
Chatham albatross (*Thalassarche eremita*)	En, Mig	There is only one known breeding area for this species – The Pyramid, off the east coast of New Zealand (Robertson et al., 2003). The Chatham albatross forages in the coastal waters of Tasmania and southern and eastern New Zealand, and there is some evidence to suggest that the species undertakes migrations to the coast of South America. This species is considered a rare visitor to south east Australian waters.	**Unlikely to occur** Core habitat for this species is not found within the APX-East corridor footprint.
Southern royal albatross (*Diomedea epomophora epomophora*)	V, Mig	A marine, pelagic albatross with a wide distribution that includes south-east NSW (Department of the Environment, 2014o). Breeding takes place off the south coast of New Zealand (Pizzey and Knight, 1999). Feeding areas for the southern royal albatross are mostly between Western Australia and South America in the Southern Ocean. The general migratory pathway is thought to be from the breeding area to South American waters (Marchant and Higgins, 1990). Overwinter areas include New Zealand, south-eastern Australian and Chilean waters, and the southern Indian Ocean (Robertson and Kinsky, 1972). This species is moderately common in offshore waters of southern Australia (Pizzey and Knight, 1999). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**Likely to occur** This species is likely to occur in the area as a transient visitor.
Wandering albatross (*Diomedea exulans* (*sensu lato*))	V, Mig	Species undertakes extensive circumpolar migrations. Breeding areas are confined to Antarctic and sub-Antarctic islands in the Atlantic Ocean, Indian Ocean and	**Likely to occur** This species is likely to occur in the area as a

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		waters off the southern coast of New Zealand. There are a number of wandering albatross that migrate during the non-breeding season to the coastal waters off Woollongong, south of Sydney (Nicholls and Robertson, 2007). Juveniles migrate from their natal grounds to the subtropical Indian Ocean and Tasman Sea (Weimerskirch et al., 2006). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	transient visitor.
Antipodean albatross (*Diomedea exulans antipodensis*)	V, Mig	Endemic to Antipodes Island in the sub-Antarctic waters south-east of New Zealand; however, it forages in the south-west Pacific Ocean, Southern Ocean and Tasman Sea (Walker and Elliot, 2006). The species is also known to forage off the coast of NSW (Department of the Environment, 2014p). Antipodes Island (south-west of New Zealand) is the major breeding area, although a small colony also nests on Campbell Island (south of New Zealand) (Walker and Elliot, 2006). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**Likely to occur** This species is likely to occur in the area as a transient visitor.
Gibson's albatross (*Diomedea exulans gibsoni*)	V, Mig	Widely distributed between latitudes 30 °S and 50 °S, and is known to forage in oceans off south-east Australia (Department of the Environment, 2014q). Nesting occurs on Adam's Island and Auckland Island off the coast of New Zealand. Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**May occur** This species may occur in the area as a transient visitor.
White-bellied storm-petrel (*Fregetta grallaria grallaria*)	V	Occurs in the tropical and subtropical waters of the Pacific,	**Likely to occur**

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		Indian and Atlantic Oceans, and is known to occur off the coast of NSW (Marchant and Higgins, 1990). It breeds in colonies on small islets and rocks in the Lord Howe Island (north-east of Sydney) and Kermadec Island complexes (north-east of New Zealand) (Hutton, 1991; Marchant and Higgins, 1990; McAllan et al., 2004). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	This species is likely to occur in the area as a transient visitor.
Northern giant-petrel (*Macronectes halli*)	V, Mig	Breeding occurs on sub-Antarctic islands and in South Georgia (Marchant and Higgins, 1990). Adult northern giant-petrels generally remain close to breeding areas year-round; however, juveniles undertake long dispersal events, although these movements are not well-understood (Marchant and Higgins, 1990). This species is commonly seen in the winter months in the inshore and offshore waters of Sydney (Pizzey and Knight, 1999). Inshore and offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**Likely to occur** This species is likely to occur in the area as a transient visitor.
Kermadec petrel (western) (*Pterodroma neglecta neglecta*)	V	A pelagic petrel of the Pacific Ocean (Marchant and Higgins, 1990). This species breeds on islands, islets and atolls in the southern Pacific Ocean. Within Australia, the Kermadec petrel nests at Ball's Pyramid (off the coast of Port Macquarie) and Phillip Island. This species occasionally reaches the eastern coast of the Australian mainland. Offshore waters within the APX-East corridor provide suitable	**May occur** This species may occur in the area as a transient visitor.

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		foraging habitat for the species.	
Australian fairy tern (*Sternula nereis nereis*)	V	Known from the coastline around Australia (excluding the Northern Territory), but sightings are concentrated in Victoria, South Australia, Western Australia and Tasmania (Department of the Environment, 2014r). It is now considered to be extinct in NSW (Department of the Environment, 2014r).	**Unlikely to occur** Suitable habitat for this species occurs in the region, however, the species is presumed extinct in NSW.
Buller's albatross (*Thalassarche bulleri*)	V, Mig	Inhabits the sub-tropical and sub-Antarctic waters of the southern Pacific Ocean (Marchant and Higgins, 1990). This species breeds in the Chatham, Snares and Solander Islands in New Zealand, but its distribution extends into Australian waters, including off the coast of Sydney (Department of the Environment, 2014s). Migration and dispersal patterns are poorly understood, although there is some evidence that juvenile birds migrate to the Humboldt Current (Marchant and Higgins, 1990). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**May occur** This species may occur in the area as a transient visitor.
Shy albatross (*Thalassarche cauta cauta*)	V, Mig	Occurs in Australian waters below 25 °S, but is most frequently observed off south-east Australia and Tasmania (Brothers et al., 1997; Hedd et al., 2001). The species is less oceanic than most species, and is more frequent inshore than offshore (Marchant and Higgins, 1990). Breeding areas are in the Bass Strait and off southern Tasmania (Marchant and Higgins, 1990). Although endemic to Australia, this species does undertake migrations throughout the southern oceans, from Africa through to South	**Likely to occur** This species is likely to occur in the area as a transient visitor.

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		America (Marchant and Higgins, 1990). Coastal and offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	
Salvin's albatross (*Thalassarche cauta salvini*)	V, Mig	This species breeds off the south coast of New Zealand, and Crozet Island in the Indian Ocean (Gales, 1998). The foraging area for this species covers much of the southern Pacific Ocean, and it is particularly associated with the Humboldt Current (Marchant and Higgins, 1990). Salvin's albatross are less oceanic than most species, and are described as being more frequent inshore than offshore (Marchant and Higgins, 1990). Coastal and offshore waters within the APX-East corridor possibly provide suitable foraging habitat for the species.	**May occur** This species may occur in the area as a transient visitor.
White-capped albatross (*Thalassarche cauta steadi*)	V, Mig	Common off the coast of southeast Australia (Department of the Environment, 2014t). Breeding takes place off the south coast of New Zealand (Marchant and Higgins, 1990). Little is known of the breeding biology or migration patterns of this species (Department of the Environment, 2014t). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**May occur** This species may occur in the area as a transient visitor.
Black-browed albatross (*Thalassarche melanophris*)	V, Mig	A pelagic species that occurs throughout Antarctic, sub-Antarctic and sub-tropical waters (Marchant and Higgins, 1990). Breeding occurs on sub-Antarctic and Antarctic islands (Marchant and Higgins, 1990).The black-browed albatross migrates to the continental shelves of South	**May occur** This species may occur in the area as a transient visitor.

Species name	Status	Habitat description and availability within the APX-East corridor	Likelihood of occurrence within the APX-East corridor
		America, South Africa, New Zealand and Australia during the winter months (Marchant and Higgins, 1990). Offshore waters within the APX-East corridor possibly provide suitable foraging habitat for the species.	
Campbell albatross (*Thalassarche melanophris impavida*)	V, Mig	The species is known to forage over the continental shelf off NSW, Victoria and Tasmania (Department of the Environment, 2014u). The only known breeding area for this species is Campbell Island, off the southern coast of New Zealand (Department of the Environment, 2014u; Marchant and Higgins, 1990). Offshore waters within the APX-East corridor provide suitable foraging habitat for the species.	**Likely to occur** This species is likely to occur in the area as a transient visitor.

Notes: En: Endangered, V: Vulnerable, Mig: Migratory

Terrestrial Species

The Protected Matters search identified 34 threatened terrestrial flora and fauna species that have the potential to occur within APX-East corridor and 10 km buffer area. The terrestrial component of the project includes a cable landing site located in Dunningham Park. This area, located landward of the dune and beach system, is a maintained grassy area, with some small trees (Plate 1).

Threatened terrestrial species identified in the Protected Matters search include:

- Eight terrestrial mammals
- One terrestrial reptile
- Six terrestrial birds
- Two frogs
- 17 plants

Suitable habitats within the APX-East project footprint exist for a number of species, such as the white-bellied sea eagle. However, for the majority of species, suitable habitats are absent, and thus, they are either unlikely to occur or they may occur within the project footprint. Further information relating to the life history of each of these species (which has informed this assessment) is provided in the Threatened Species Summary Information below.

Listed Migratory Species

Seventy-six migratory species (in addition to those listed as threatened and migratory) were identified by the Protected Matters search as relevant to the APX-East corridor within the SSPZ, including:

- Eight marine mammals
- Two sharks
- Three marine birds
- 26 wader birds
- Eight terrestrial birds

To understand potential to impact upon these species a likelihood of occurrence ranking was attributed to each migratory species, based on the following framework:

- Unlikely to occur: species has not been recorded in the region AND/OR current known distribution does not encompass APX-East corridor AND/OR suitable habitat is generally lacking from APX-East corridor.
- May occur: mapped species' distribution incorporates APX-East corridor AND potentially suitable habitat occurs within the APX-East corridor.
- Likely to occur: species has been recorded in the region and potentially suitable habitat is present within the APX-East corridor.

Marine Mammals

Eight migratory marine mammal species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 6). These species are all highly mobile and are only likely to occur in the region as transient visitors during annual migrations. Table 6 provides a description of each of the species and their migratory patterns, as well as a likelihood of occurrence assessment based on this information. Further information relating to their life history and distribution is provided in the Threatened Species Summary Information below.

Table 6 Marine mammals listed as Migratory

Name	Description	Migratory patterns	Likelihood of occurrence within the APX-East corridor
Antarctic minke whale (*Balaenoptera bonaerensis*)	A robust, generally solitary baleen whale. Known throughout the Southern Hemisphere from 55 °C. Recorded off the coast of NSW (Department of the Environment, 2014v).	Migrates between winter tropical/sub-tropical breeding grounds to Antarctic feeding grounds in summer (Department of the Environment, 2014v).	**Likely to occur** This species is likely to transit the area during annual migrations
Bryde's whale (*Balaenoptera edeni*)	A small baleen whale that is not considered gregarious. Found in	Patterns of migration are not clearly understood. Some	**Likely to occur**

Name	Description	Migratory patterns	Likelihood of occurrence within the APX-East corridor
	temperate to tropical inshore and offshore waters. Recorded off the coast of NSW (Department of the Environment, 2014w).	evidence that the offshore form may migrate to tropical water during winter (Department of the Environment, 2014w).	This species is likely to transit the area during annual migrations
Pygmy right whale (*Caperea marginate*)	The smallest baleen whale and the only right whale with a dorsal fin. Predominantly associated with coastal waters. A low number of observations of this species have been made in NSW due to its distribution being largely centred between 32° S and 47° S. (Department of the Environment, 2014x).	Patterns of migration are not clearly understood (Department of the Environment, 2014x). In Australian waters, weaned juveniles migrate south where prey is more abundant (Kemper, 2002).	**May occur** This species may transit the area during annual migrations
Dugong (*Dugong dugon*)	The dugong is a large herbivorous marine mammal, and is the only extant species of the family Dugongidae. It is closely associated with seagrass meadows and is typically found along the coastline of north Australia (Department of the Environment, 2014y). It is occasionally observed in NSW, with sightings north of Sydney (Allen et al., 2004).	Migrate in response to the changing availability of suitable seagrasses, or in response to water temperature (Marsh et al., 2002). Known to undertake long-distance migration/dispersal events (Department of the Environment, 2014y; Sheppard et al., 2006).	**May occur** This species may transit the area during migrations between food sources. Core habitat for this species is not found within the APX-East corridor footprint.
Dusky dolphin (*Lagenorhynchus obscurus*)	A small, gregarious dolphin that can form schools of hundreds of individuals (Department of the Environment, 2014z). Can dive to	Known to undertake migrations, but patterns are not known for Australian populations (Department of the	**Unlikely to occur** The APX-East corridor footprint is not

Name	Description	Migratory patterns	Likelihood of occurrence within the APX-East corridor
	depths of at least 150 m. Rarely observed in Australia; this species has not been observed in NSW waters.	Environment, 2014z).	within this species known range.
Killer whale (*Orcinus orca*)	Largest of the Delphinidae with distinctive black, white and grey markings. Distributed along the Australian coast, but most frequently observed around Tasmania, South Australia and Victoria (Department of the Environment, 2014aa). This species has been recorded from the Sydney region.	Migratory behaviour is not well-known, and there is evidence that patterns of movement are specific to populations (Department of the Environment, 2014aa).	**May occur** This species may occur in the area as a transient visitor. Core habitat for this species is not found within the APX-East corridor footprint.
Sperm whale (*Physeter macrocephalus*)	Largest of the toothed whales. Gregarious species that forms an average pod size of 25 individuals. Females and young males restricted to warmer waters. Adult males also inhabit Antarctic waters. Known from all Australian states, including NSW (Department of the Environment, 2014ab).	Adult males migrate between Antarctic waters and warmer waters (Bannister et al., 1996). Known migratory pathway off the coast of Albany in Western Australia. Generally, this species moves south in summer, and north in winter (Whitehead, 2002).	**May occur** This species may transit the area during annual migrations Core habitat for this species is not found within the APX-East corridor footprint.
Indo-Pacific humpback dolphin (*Sousa chinensis*)	A stout dolphin of the north Australian coastline. Known to occur in NSW. While the distribution is considered continuous, there are population 'hotspots' along the east coast. These hotspots are outside the APX-East corridor	Known to be migratory, although specific patterns in Australia are not known (Department of the Environment, 2014ac; Parra, 2006).	**May occur** This species may occur in the area as a transient visitor. Core habitat for this species is not

Name	Description	Migratory patterns	Likelihood of occurrence within the APX-East corridor
	(Department of the Environment, 2014ac).		found within the APX-East corridor footprint.

Sharks

Two migratory shark species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 7). Both of these species are highly mobile and are only likely to occur in the region as transient visitors. Table 7 provides a description of each of the species and their migratory patterns, as well as a likelihood of occurrence assessment based on this information. Further information is provided in the Threatened Species Summary Information below.

Table 7 Sharks listed as Migratory

Name	Description	Migratory patterns	Likelihood
Shortfin mako (*Isurus oxyrinchus*)	The shortfin mako is a large bodied shark in the Lamnidae family that reaches approximately 4 m. Males mature at around 2 m with females maturing at a 2.8 m (Last and Stevens, 2009). The species is captured worldwide in commercial fisheries, and forms a component of the recreational game fisheries in Australian waters, including off Sydney (Department of the Environment, 2014ad).	The species has a circum-global distribution, occurring most frequently in pelagic waters from temperate and subtropical waters (Department of the Environment, 2014ad; Last and Stevens, 2009). Recent tracking studies from South Australia indicate that the species is capable of large-scale movements, with individuals tagged from the Great Australia Bight migrating westward into subtropical waters of the Indian Ocean and eastward into the Coral Sea (Rogers, 2011).	**Likely to occur** This species likely occurs in the area as a transient visitor.
Porbeagle (*Lamna nasus*)	The porbeagle is a large bodied, robust shark in the Lamnidae	Little is known in Australian waters, but the species has	**May occur** This species

Name	Description	Migratory patterns	Likelihood
	family that reaches approximately 3.5 m. Males mature at around 1.65 m, with females maturing at 2 m (Last and Stevens, 2009). When encountered in Australian waters, the porbeagle is likely confused with the shortfin mako due to their similar morphology (Department of the Environment, 2014ae).	a circum-global distribution, predominantly in temperate waters less than 18 °C (Department of the Environment, 2014ae; Last and Stevens, 2009). May occur in NSW waters, particularly during winter months.	may occur in the area as a transient visitor.

Marine Birds

Three migratory marine bird species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 8). All of these species are highly mobile and are only likely to occur in the region as transient visitors. Table 8 provides a description of each of the species and their migratory patterns, as well as a likelihood of occurrence assessment based on this information.

Table 8 Marine birds listed as Migratory

Name	Description	Migratory patterns	Likelihood
Streaked shearwater (*Calonectris leucomelas*)	A marine, pelagic shearwater. Distributed throughout the north-west Pacific Ocean, with breeding areas along the coast and/or islands of China, Japan, North Korea, South Korea and Russia. Recorded in NSW (Department of the Environment, 2014af; Marchant and Higgins, 1990).	Undertakes migrations to warmer waters during winter, typically to Vietnam, the Philippines, New Guinea and Australia (Marchant and Higgins, 1990; Takahashi et al., 2008; Yamamoto et al., 2010).	**May occur** This species may overfly the region during annual migration. Key habitat not known within the APX-East corridor footprint.
Flesh-footed shearwater (*Ardenna carneipes*)	A large shearwater that occurs predominately in subtropical waters across the Indian and Pacific Oceans (Department of the Environment, 2014ag). Occurs in coastal and marine waters of southern Australia. Described as fairly	In general, migrates north at the end of the breeding season in May. Lord Howe Island population migrates north to the coast off Korea, returning in early September (Department of the Environment,	**May occur** This species may overfly the region during annual migrations. Key habitat not known

Name	Description	Migratory patterns	Likelihood
	common off NSW, and is known to breed on Lord Howe Island (Marchant and Higgins, 1990).	2014ag; Marchant and Higgins, 1990).	within the APX-East corridor footprint.
Little tern (*Sterna albifrons*)	A small, slight tern with gregarious behaviour. Australian population consists of several sub-populations, with the eastern population's distribution covering the east coast of Australia (Department of the Environment, 2014ah). Occurs in sandy coastlines and mangrove mudflats (Department of the Environment, 2014ah). This species has been recorded from the Sydney region.	Can be sedentary, or wholly or partly migratory (Department of the Environment, 2014ah). The eastern population is migratory and vacates the east coast in late summer. The migratory pathway of this population is not understood (Department of the Environment, 2014ah).	**May occur** This species may overfly the region during annual migrations. Key habitat not known within the APX-East corridor footprint.

Wading Birds

Twenty-six migratory wading bird species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ (Table 9). All of these species are highly mobile and are only likely to occur in the region as transient visitors. Table 9 provides a description of each of the species and their migratory patterns, as well as a likelihood of occurrence assessment based on this information.

Table 9 Wading birds listed as Migratory

Name	Description	Migratory patterns	Likelihood
Common sandpiper (*Actitis hypoleucos*)	A small sandpiper that is not considered gregarious. Will form small flocks. Concentrated around the coastlines of Australia, but is also found around inland waters (Department of the Environment, 2014ai). Most common in north and west Australia (Higgins and Davies, 1996). Breeds in Europe, Asia and on occasion, Africa	Australian population undertakes migrations in February to breeding grounds in eastern Russia. Post-breeding migrations to Australia begin in July. This species arrives in NSW in August (Higgins and Davies, 1996).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.

Name	Description	Migratory patterns	Likelihood
	(Higgins and Davies, 1996). Australian population breeds in eastern Russia (Department of the Environment, 2014ai).		
Great egret (*Ardea modesta*)	Occurs throughout Australia in wetland habitats. Generally solitary, but will form small foraging groups. Is a colonial breeder that nests in swamps and mangrove forests (Higgins and Davies, 1996).	Undertakes multi-directional migration after breeding, and generally moves towards coastal habitats during the dry season (Department of the Environment, 2014aj).	**May occur** This species may overfly the region during annual migrations.
Cattle egret (*Ardea ibis*)	Found throughout much of Australia. A small, solid egret with distinctive breeding plumage. Breeds in colonies throughout its range (Department of the Environment, 2014ak). Associated with wetland habitats, but often observed on grassy flats, including agricultural pastures and crops (Marchant and Higgins, 1990).	A partial migrant. Population in south-east Queensland and north-east NSW winters in south-east Australia and New Zealand (Marchant and Higgins, 1990).	**May occur** This species may overfly the region during annual migrations. Key habitat not known within the APX-East corridor footprint.
Ruddy turnstone (*Arenaria interpres*)	Widespread in coastal regions of Australia, although has been recorded inland (Higgins and Davies, 1996). Closely associated with rocky coastlines or coral reefs (Department of the Environment, 2014al). Roosts above the tideline on beaches (Higgins and Davies, 1996). Does not breed in Australia (Department of the Environment, 2014al).	Species generally moves south during the non-breeding season. East Australian and New Zealand population migrate south from east Asia across the Pacific Ocean, arriving from September (Department of the Environment, 2014al).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.

Name	Description	Migratory patterns	Likelihood
Sharp-tailed sandpiper (*Calidris acuminata*)	A stout sandpiper that inhabits the muddy margins of freshwater wetlands. Forages on bare substrate or in shallow water. Inhabits coastal and inland waters throughout Australia. Eleven important international sites for this species exist in NSW, including Tuggerah Lakes, approximately 100 km north of Sydney (Bamford et al., 2008). Breeds in northern Siberia (Higgins and Davies, 1996).	Departs breeding grounds in late June, moving down through Asia and New Guinea. Arrives in Australia mid-August. Returns to breeding grounds in April (Department of the Environment, 2014am).	**Likely to occur** This species may overfly the region during annual migrations. Particularly given its known distribution approximately 100 km north of Sydney.
Sanderling (*Calidris alba*)	A small wader of coastal and inland waters in Australia. Generally found on sandy beaches or rocky outcrops exposed to wave action (Department of the Environment, 2014an; Higgins and Davies, 1996). Described as being gregarious. Breeds in northern parts of Russia and North America, and some islands of the Arctic Ocean (Higgins and Davies, 1996).	Moves from breeding areas to the south in the non-breeding season. Arrives in north-west Australia in September. Generally arrive in the Sydney area in August (Higgins and Davies, 1996).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.
Red knot (*Calidris canutus*)	Robust wader found along the coastlines of Australia. Inhabits sheltered intertidal flats and sand beaches. Typically scarce in NSW, due to the lack of suitable habitat (Higgins and Davies, 1996). Does not breed in Australia (Department of the Environment,	Migrates from breeding grounds in north-east Siberia to Australia, arriving in August (Department of the Environment, 2014ao).	**Unlikely to occur** Suitable habitat for this species is not found in the region.

Name	Description	Migratory patterns	Likelihood
	2014ao).		
Curlew sandpiper (*Calidris ferruginea*)	A small, slender, gregarious sandpiper that is found along the coastlines and inland waters of Australia. Most common on sheltered intertidal mudflats. Roosts on dry beaches, spits and islets (Department of the Environment, 2014ap). Breeds only in Siberia.	Leaves breeding grounds in July and August. Arrives in Australia in late August and early September (Higgins and Davies, 1996). Flocks stopover in northern Australia before moving on to south-eastern Australia. Majority of birds arrive in September. Return migration commences in March (Department of the Environment, 2014ap).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.
Red-necked stint (*Calidris ruficollis*)	The smallest shorebird in Australia. This species occurs near coastal and inland waters, but are known to use wet paddocks and grasslands (Higgins and Davies, 1996). Forages on exposed mudflats and samphire. Breeds in Siberia and Alaska (Higgins and Davies, 1996).	Departs from breeding grounds June through to August. Reaches Australia from August, although most arrive in September. Within south-east Australia, birds inhabit inland wetlands from October to November, and then move to marine habitats in December (Department of the Environment, 2014aq).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.
Great knot (*Calidris tenuirostris*)	A large wading bird that has been observed in sheltered coastal habitats around Australia. Also found on mudflats and sand flats. Rarely occurs inland (Higgins and Davies, 1996). This species	Moves south after breeding to Australia, with migration starting in June. Large flocks arrive in late August through to early September. The majority of the	**Likely to occur** This species may overfly the region during annual migrations or

Name	Description	Migratory patterns	Likelihood
	roosts in large congregations in open areas. Breeds in north-eastern Siberia and Russia (Department of the Environment, 2014ar). This species is known to occur in the Sydney region.	population stays in northern Australia, although some birds move further south. Departure to the breeding grounds commences in March (Higgins and Davies, 1996; Lane, 1987).	occur in the area as a transient visitor.
Double-banded plover (*Charadrius bicinctus*)	A moderately sized dotterel that is commonly observed in pairs during the breeding season and in loose groups during the non-breeding season (Department of the Environment, 2014as). Gregarious with other wading species. Found in wetlands, beaches, saltmarshes and grassy flats. Breeds in New Zealand (Marchant and Higgins, 1993). This species is known to occur in the Sydney region.	Partly migratory and generally dispersive. Majority of population migrates to northern New Zealand, south-east Australia or south-west Australia for winter period (Marchant and Higgins, 1993).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.
Greater sand plover (*Charadrius leschenaultii*)	A moderately sized plover with sexually dimorphic plumage during the breeding season. Gregarious with other wading birds during the non-breeding season (Marchant and Higgins, 1993). Occurs in coastal regions throughout Australia, but is most concentrated in the north. Breeds in central Asia. This species is known to occur in the Sydney region.	Migrates from breeding grounds in July. Passes through south-east Asia into northern Australia, arriving late July (Department of the Environment, 2014at). Follows coastline flyways when moving within Australia. Movement back to breeding grounds commences in late February.	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.

Name	Description	Migratory patterns	Likelihood
Lesser sand plover (*Charadrius mongolus*)	A smaller plover with sexually dimorphic plumage during the breeding season. Gregarious during the non-breeding season, and is particularly associated with the greater sand plover. Occurs in coastal regions of all states, but mainly through north and east Australia. Internationally important sites for this species in NSW include the Hunter River estuary, Tuggerah Lakes and Clarence River estuary. Breeds in north-east and central Asia (Department of the Environment, 2014au). This species is known to occur in the Sydney region.	Migrates south for the winter months. Arrives in northern Australia in August, and disperses along the coastlines to southern areas. Commences the return journey to breeding grounds in April (Department of the Environment, 2014au; Marchant and Higgins, 1993).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.
Oriental plover (*Charadrius veredus*)	A delicate, moderately sized, gregarious plover that forms flocks (Marchant and Higgins, 1993). Observed in coastal habitats and open, sparsely vegetated grasslands. Breeds in Mongolia and Russia (Department of the Environment, 2014av). Within Australia, most records are concentrated in Western Australia.	Commences migration from breeding grounds in July, passing through China. Within Australia, it disperses to coastal regions, then onward to inland habitats. The return journey commences in February (Marchant and Higgins, 1993).	**May occur** This species may overfly the region during annual migrations.
Latham's snipe (*Gallinago hardwickii*)	The largest Australian snipe. Generally solitary or in loose congregations of few individuals (Higgins and Davies, 1996). Habitat includes permanent and ephemeral wetlands with dense vegetation	Depart from breeding grounds from July through to November. The migratory pathway to Australia is poorly understood. Flocks start to arrive in Australia in July	**Likely to occur** This species may overfly the region during annual migrations or occur in the

Name	Description	Migratory patterns	Likelihood
	for cover (Department of the Environment, 2014aw). Distribution covers east and south-east Australia (Department of the Environment, 2014aw). Breeds in Japan and eastern Russia. This species is known to occur in the Sydney region.	(Higgins and Davies, 1996). Birds commence the return journey in late February.	area as a transient visitor.
Grey-tailed tattler (*Heteroscelus brevipes*)	A moderately sized wading bird found in the coastal regions of Australia, although is most concentrated in the north (Higgins and Davies, 1996). In NSW, species is most frequently observed in the coastal regions north of Sydney. Generally prefers sheltered coastal habitats, and roosts in mangrove forests (Department of the Environment, 2014ax). Breeds in Siberia.	Moves south from breeding grounds along the east coast of Asia. Arrives in Australia in August onwards. Commences the return journey in April (Department of the Environment, 2014ax).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.
Broad-billed sandpiper (*Limicola falcinellus*)	A small bodied sandpiper with a distinctively shaped bill. Known to occur in all states, but is most common in the north and north-west. In NSW, is regularly observed in small numbers (Department of the Environment, 2014ay). Inhabits sheltered coastal areas and mudflats, although have been observed on reefs and rocky outcrops (Higgins and Davies, 1996). Breeds in Siberia and north-	Commences migration from breeding grounds in late July, and travel through Russia, Japan and Borneo. Arrive in north-west Australia around October. The Return migration commences in April (Department of the Environment, 2014ay).	**Likely to occur** This species may overfly the region during annual migrations or occur in the area as a transient visitor.

Name	Description	Migratory patterns	Likelihood
	eastern Europe (Department of the Environment, 2014ay).		
Bar-tailed godwit (*Limosa lapponica*)	Large wading bird with a wingspan of up to 75 cm. Distinctive upward curving bill. Occurs in coastal habitats and brackish wetlands, but is rarely observed inland. Forages in sheltered intertidal areas, including beaches. Roosts on sandy beaches, sandbars and spits (Marchant and Higgins, 1993). A site (among others in Australia) of international importance exists in the Hunter estuary in NSW (Department of the Environment, 2014az). Breeding areas are in northern Russia, Alaska and Scandinavia (Marchant and Higgins, 1993).	Undertakes migrations south from breeding grounds in the Northern Hemisphere. Depart for Australia in July, and arrive in August in north-west Australia at which point small numbers disperse throughout Australia. Commences the return journey in February (Marchant and Higgins, 1993).	**May occur** Coogee Beach within the APX-East corridor footprint may provide suitable foraging and/or roosting habitat for this species.
Black-tailed godwit (*Limosa limosa*)	The black-tailed godwit is a large bodied wader in the subfamily Tringinae. They occur singly or in small or large groups, within the coastal fringes of Australia, including NSW. Inhabits sheltered estuaries, bays and lagoons with intertidal sandflats or mudflats (Department of the Environment, 2014ba).	Breeds in the northern hemisphere, and migrates into Australia from late August, including NSW (Higgins and Davies, 1996). Returns to breeding grounds from late summer into early Autumn (Department of the Environment, 2014ba).	**Unlikely to occur** Areas with the APX-East corridor footprint are unsuitable for foraging and roosting.
Eastern curlew (*Numenius madagascariensis*)	The eastern curlew is a large bodied wader in the family Scolopacidae. It has a primarily coastal	Breed in northern hemisphere, migrating into Australia in boreal winter. Arrives in	**Unlikely to occur** Areas with the APX-East

Name	Description	Migratory patterns	Likelihood
	distribution, known from all states in Australia (Department of the Environment, 2014bb). The species roosts in large flocks, separate to other waders. Forages in open, sheltered intertidal mudflats and sandflats. Also in saltmarsh, rockpools, coral reefs and ocean beaches. Roosts on sandy spits and islets (Marchant and Higgins, 1993).	eastern Australia, such as NSW, from mid-August to December (Department of the Environment, 2014bb; Marchant and Higgins, 1993).	corridor footprint are generally unsuitable for foraging and roosting.
Little curlew (*Numenius minutus*)	The smallest known curlew in the family Scolopacidae. Known from coastal regions in Australia distributed largely between Port Headland, WA and south-east Queensland. This species moves in flocks of thousands. Forages in grasslands and sedgelands near to pools or floodplains. Also known to inhabit sheltered beaches, grassy flats and saltmarshes (Department of the Environment, 2014bc).	Breeds in Russia and departs northern hemisphere in late May. Arrive in northern Australia in October and generally depart prior to March (Department of the Environment, 2014bc).	**May occur** Species is known from the area, and sheltered beach within the APX-East corridor footprint may provide habitat for this species.
Whimbrel (*Numenius phaeopus*)	A medium sized curlew in the family Scolopacidae. They occur primarily in coastal habitats, particularly sheltered intertidal mudflats, with the largest single aggregation known from Shoalwater Bay and Broad Sound in Queensland (Department of the Environment, 2014bd).	Breeds in the northern hemisphere, the whimbrel enters Australia in August and September and returns to northern hemisphere in February (Department of the Environment, 2014bd; Higgins and Davies, 1996).	**Unlikely to occur** Roosting and foraging habitat is absent from the APX-East corridor footprint.

Name	Description	Migratory patterns	Likelihood
Pacific golden plover (*Pluvialis fulva*)	A medium sized plover from the family Charadriidae. They often forms flocks of between 20-50 and occur throughout the coastal margins of Australia, including the east-coast. This species forages on sandflats, mudflats, the margins of estuaries and lagoons, rocky shores, reefs and islands (Department of the Environment, 2014be)	Breeds in northern hemisphere and migrates into Australia in the boreal winter, arriving in NSW in September and October (Department of the Environment, 2014be). Departs Australia in autumn, prior to the austral winter (Marchant and Higgins, 1993).	**Unlikely to occur** Roosting and foraging habitat is absent from the APX-East corridor footprint.
Grey plover (*Pluvialis squatarola*)	A medium sized plover in the family Charadriidae. The species occurs as solitary or in small flocks in coastal margins throughout Australia. Forages in exposed mudflats and beaches, occasionally in wetlands and pasture; roosts on sheltered sandy areas (Department of the Environment, 2014bf).	The species breeds in the northern hemisphere, migrating into Australia and southern hemisphere countries during the boreal winter (Department of the Environment, 2014bf). Arrive in eastern Australia between August to December (Marchant and Higgins, 1993).	**May occur** Suitable roosting and foraging habitat for this species occurs within the APX-East corridor footprint.
Marsh sandpiper (*Tringa stagnatilis*)	A medium sized wader in the family sub-family Tringinae. The species occur singly or in small to large flocks along coastal fringes. Prefers wetlands (including freshwater wetlands), tidal floodplains and mudflats. This species generally avoids coastal habitats (Department of the Environment, 2014bg).	The species breeds in eastern Europe, Siberia and northern China, migrating during boreal winter months into southern hemisphere countries, including Australia (Department of the Environment, 2014bg). Migrates out of Australia in March-April (Marchant and Higgins, 1993).	**Unlikely to occur** Roosting and foraging habitat is absent from the APX-East corridor footprint.

Name	Description	Migratory patterns	Likelihood
Terek sandpiper (*Xenus cinereus*)	The Terek sandpiper is a pale-brownish-grey bird in the family Scolopacidae. It is a medium sizes wader that generally roosts communally in mangrove areas, and forages on mudflats (NSW Department of Environment and Heritage, 2012a)	Breeds in Eurasia, moves south into non-breeding areas during boreal winter, including eastern Australia Predominantly coastal distribution and occurs in NSW between the northern Rivers Region and Lake Wollumboola (Department of the Environment, 2014bh).	**Unlikely to occur** Roosting and foraging habitat is absent from the APX-East corridor footprint.

Terrestrial Birds

Eight terrestrial bird species were identified through the Protected Matters search as relevant to the APX-East corridor within the SSPZ. All of these species are highly mobile and are only likely to occur in the region as transient visitors. Further information relating to the life history of each of these species, including migratory patterns is provided in Table 10.

Table 10 Terrestrial birds listed as Migratory

Name	Description	Migratory patterns	
Fork-tailed swift (*Apus pacificus*)	A larger aerial species in the Apodidae family. Occurs across much of Australia, and is recorded in all regions of NSW, particularly east of the Great Divide (Higgins, 1999). Does not undertake breeding in Australia.	Migrates from Siberia to Australia in October, generally via the Northern Territory. Species is highly dispersive within Australia (Department of the Environment, 2014bi).	**May occur** Suitable foraging habitat for this species occurs within the APX-East corridor footprint.
White-bellied sea-eagle (*Haliaeetus leucogaster*)	Large, solitary raptor of the Australian coastline and offshore islands, although has been observed inland around larger waterbodies (Department of the Environment, 2014bj). Breeding sites are typically along the east coast, including NSW.	Adults generally sedentary within their foraging range (Marchant and Higgins, 1993). Juveniles and sub-adults undertake extensive long-distance dispersal, although there is no specific pattern in these events (Marchant and	**Likely to occur** Suitable foraging habitat for this species occurs within the APX-East corridor footprint

Name	Description	Migratory patterns	
		Higgins, 1993).	
White-throated needletail (*Hirundapus caudacutus*)	A large, robust, gregarious swift (Department of the Environment, 2014bk). Occurs throughout east and south-east Australia, particularly along the coastal regions (Higgins, 1999). Breeding areas restricted to Asia.	Leaves breeding grounds from late August, and cross to Australia in September via the Torres Strait. Species moves down through the east coast on either side of the Great Divide. Migration back to breeding grounds starts mid-March (Higgins, 1999).	**Likely to occur** The species is wide ranging and suitable foraging habitat for this species occurs within the APX-East corridor footprint
Rainbow bee-eater (*Merops ornatus*)	The only Australian bee-eater that occurs across much of mainland Australia. Absent from Tasmania. Observed in a broad variety of habitats, including disturbed areas (specifically urbanised areas) and coastal regions (Department of the Environment, 2014bl).	Undertakes complex migratory events that are poorly understood. In Australia, it is thought that southern populations migrate north for the winter period, and that the northern populations are sedentary (Department of the Environment, 2014bl).	**May occur** The species is wide ranging, however, suitable foraging habitat may be lacking within the APX-East corridor footprint
Black-faced monarch (*Monarcha melanopsis*)	A small bird that occurs along eastern Australia. Is generally associated with rainforest habitats, although may inhabit mangroves, coastal scrub and suburban parks and gardens (Department of the Environment, 2014bm).	Migratory patterns are poorly understood. However, it is generally thought that this species spends most of the year in eastern Australia, and migrates to Papua New Guinea for the winter months (Department of the Environment, 2014bm).	**Likely to occur** The species is wide ranging and suitable foraging habitat for this species occurs within the APX-East corridor footprint

Name	Description	Migratory patterns	
Spectacled monarch (*Monarcha trivirgatus*)	A small bird that occurs along eastern Australia. Occurs in rainforest, densely vegetated gullies and around waterside vegetation (Department of the Environment, 2014bn).	Migrates south towards NSW during summer months from September through to May (Pizzey and Knight, 1999).	**Likely to occur** The species is wide ranging and suitable foraging habitat for this species occurs within the APX-East corridor footprint
Satin flycatcher (*Myiagra cyanoleuca*)	A small, sexually-dimorphic bird. Occurs along the east coast of Australia. In NSW, are widespread to the east of the Great Divide. Generally prefer heavily vegetated areas, but will also move through more open country when migrating (Department of the Environment, 2014bo).	Migrates to Papua New Guinea and northern Australia for the winter months. Moves south in spring to south-east Australia (Pizzey and Knight, 1999).	**Likely to occur** The species is wide ranging and suitable foraging habitat for this species occurs within the APX-East corridor footprint
Rufous fantail (*Rhipidura rufifrons*)	A small flycatcher with a distinctive rufous rump. Occurs along the coast and near coastal regions of eastern Australia. Prefers wet sclerophyll forests, and generally is associated with dense, scrubby vegetation. However, is known to move through urban parks and gardens (Department of the Environment, 2014bp).	Migratory patterns are poorly understood. Is described as an altitudinal migrant that moves towards sea level during the cooler months (Pizzey and Knight, 1999). May also winter north in Papua New Guinea and northern Queensland (Department of the Environment, 2014bp).	**Likely to occur** The species is wide ranging and suitable foraging habitat for this species occurs within the APX-East corridor footprint

Summary of Protected Species Occurrence

Threatened Species

Following a review of known distributions and occurrence, habitat preferences and migratory pathways, the following species were identified as likely to occur in the APX-East corridor.

- Marine mammals: 2 species
- Sharks: 1 species
- Marine birds: 8 species

For the marine mammals and marine birds, the likelihood of occurrence relates to known migration pathways overlapping with the APX-East corridor. Therefore, the interactions with the project would be limited on a temporal basis during migration events. For example, humpback whales known migration occurs in late Autumn, through to early-mid spring. As such, for deployment of the cable during summer months, interactions with this species would be negligible.

For the protected shark species, the great white shark, this species is known to occur from coastal and offshore waters of Sydney and surrounds. The species is likely to be present year round in these waters, with individuals undertaking seasonal migrations northward along the east coast, and southward into Victoria and South Australia. Given the species high mobility with a large home range, the likelihood of interaction with APX-East is considered to be negligible.

Key habitats however, are known for marine birds or marine mammals to be within the cable corridor.

Migratory Species

Upon review of known distributions an occurrence, habitat preferences and migratory pathways, the following species were identified as likely to occur in the APX-East corridor:

- Marine mammals: 2 species
- Sharks: 1 species
- Wading birds: 13 species
- Terrestrial birds: 6 species

As with protected species, the known migratory pathways drive the likelihood of occurrence for the listed migratory species. Suitable habitats exist in the APX-East corridor for some species (*e.g.* the mako shark, white bellied sea eagle). However, known aggregations and key habitats are not known for the majority of migratory species to overlap with the cable corridor. For all species, the interactions with the APX-East corridor are predicted to remain low, and in the majority of cases, they would be limited to migration events during narrow temporal scales.

Information regarding sensitive time windows during which interactions may occur with different threatened and migratory species is provided in Appendix B.

Threatened Species Summary Information

Threatened Marine Mammals

Table 11 Threatened marine mammals

Common name	Scientific name	Status		
		En	V	Mig
Marine mammals				
Blue whale	*Balaenoptera musculus*	✓		✓
Southern right whale	*Eubalaena australis*	✓		✓
Humpback whale	*Megaptera novaeangliae*		✓	✓

Notes: En: Endangered, V: Vulnerable, Mig: Migratory

Blue whale

The blue whale consists of three sub-species – the southern blue whale (*Balaenoptera musculus intermedia*), pygmy blue whale (*Balaenoptera musculus brevicauda*) and northern blue whale (*Balaenoptera musculus musculus*; only found in the northern hemisphere) (Department of the Environment, 2014b). As the southern blue whale occurs south of 60 °S, and the pygmy blue whale occurs north of 55 °S, it is likely that only the pygmy blue whale potentially occurs within the APX-East corridor.

Blue whales typically feed as individuals or in small groups. In Australia, there are only two known feeding aggregations at Perth Canyon off the coast of south Western Australia and the Bonney Upwelling, which runs along the coast of South Australia into Victoria (Attard et al., 2010). There are no known feeding aggregations within the APX-East corridor. The migratory pathways of blue whales are very poorly understood.

Southern right whale

Southern right whales (*Eubalaena australis*) are large baleen-bearing whales that are known to occur in the coastal waters of Australia, with the exception of the Northern Territory. The major calving areas are generally restricted to waters off Western Australia, South Australia and Victoria (Department of the Environment, 2014c). The closest known calving area to the APX-East corridor is off the coast of Eden in southern NSW. No specific feeding areas are known for southern right whales, as they generally depend on variable prey distribution and abundance and will migrate according to prey location (Baumgartner et al., 2006; Best and Schell, 1996).

Humpback whale

The humpback whale (*Megaptera novaeangliae*) is a moderately sized baleen-bearing whale well known for its annual migrations. Along the Australian coastline humpback whales have a number of key calving, migration and resting areas. In eastern Australia, most calves are born in the Great Barrier Reef region. However, calving also take place along the migratory pathways, including off the coast of Sydney.

During migratory events, humpback whales pass close to Cape Byron in northern NSW, and an important rest area is Twofold Bay (Eden, southern NSW). Feeding occurs primarily in the colder waters south of 55 °S, with krill forming the majority of diet (Department of the Environment, 2014d). However, opportunistic feeding has been observed near Eden in southern NSW (Department of the Environment, 2014d).

Threatened Marine Reptiles

Table 12 Threatened marine reptiles

Common name	Scientific name	Status		
		En	V	Mig
Marine turtles				
Loggerhead turtle	*Caretta caretta*	✓		✓
Leatherback turtle	*Dermochelys coriacea*	✓		✓
Green turtle	*Chelonia mydas*		✓	✓
Hawksbill turtle	*Eretmochelys imbricata*		✓	✓
Flatback turtle	*Natator depressus*		✓	✓

Notes: En: Endangered, V: Vulnerable, Mig: Migratory

Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) is a widely distributed marine reptile, occurring throughout Australian coastal and offshore zones, including warm temperate to tropical areas (Department of the Environment, 2014e). Nesting sites for the species occur throughout northern Australia from southern Queensland through to Shark Bay in WA (Limpus, 2008a). Throughout its range, the species demonstrates occupancy of coral reefs, rocky reefs, seagrass beds and inshore embayments, such as Moreton Bay. The species forages primarily on hard-bodied, slow-moving invertebrate prey, such as bivalves and decapod crabs. Throughout its range, the species faces a number of threats, including interactions with commercial fishing gear as bycatch, boat strikes and degradation of nesting beaches.

Leatherback turtle

The leatherback turtle (*Dermochelys coriacea*) is circum-globally distributed in warm temperate to tropical seas. It is the largest known marine turtle, reaching 1.6 m in curved carapace length (Department of the Environment, 2014bq). It occurs in open ocean basins, making landfall to nest at known locations including central-Queensland (Limpus, 2008b). Unlike the loggerhead turtle, the leatherback feeds mainly on gelatinous marine invertebrates. Few records exist of the species within NSW, with a single record known from waters in proximity to the APX-East corridor (Limpus, 2008b). Throughout its range, the species faces similar to threats other marine turtles, including interactions with commercial fishing gear as bycatch, ingestion of plastics, boat strikes and degradation of nesting beaches.

Green turtle

The green turtle (*Chelonia mydas*) is found throughout Australian coastal warm temperate to tropical seas. Juveniles of the species are predominantly carnivorous and shift to a vegetarian

diet upon attaining adulthood (Limpus, 2008d). Nesting occurs throughout northern Australia from central Queensland waters through to Exmouth. Following hatching, neonate and juvenile turtles remain in pelagic and offshore waters until they reach approximately 30 to 40 cm carapace length (Department of the Environment, 2014f). Given the adult's diet and habitat preferences, mature specimens are commonly encountered in seagrass beds and in proximity to macroalgal benthic habitats. The species has undergone population decline due a number of threats including degradation of nesting beaches, boat strikes, interactions with fishing gear. Currently, the species is listed as vulnerable under the EPBC Act. Although records are common from NSW waters, no known nesting sites are found along the NSW coast.

Hawksbill turtle

The hawksbill turtle (*Eretmochelys imbricata*) has a circumglobal distribution, occupying open ocean and coastal temperate and tropical seas. The species is more commonly encountered in rocky reef and coral reef areas where it feeds on sponges, seagrasses, soft corals and molluscs (Department of the Environment, 2014g). The known nesting grounds for the hawksbill turtle range from northern Queensland, through northern Australia to Exmouth in Western Australia (Limpus, 2008e). As with the other marine turtles, interactions with fishing gear as bycatch, boat strikes and degradation of nesting beaches are key threats facing this species. As with other marine turtles, no known nesting sites occur along the NSW coastline.

Flatback turtle

The flatback turtle (*Natator depressus*) has a restricted distribution in Australia between the Kimberley in Western Australia and Queensland's central east coast (Department of the Environment, 2014h). The species feeds primarily on soft corals, holothurians, and jellyfish (Limpus, 2008c) Only a handful of records are known from NSW, including a post-hatchling that was captured at Forster, on the NSW mid coast (Limpus, 2008c). Throughout its range, the flatback turtle faces threats including interactions with fishing gear as bycatch, boat strike and urbanisation and degradation of nesting beaches.

Threatened Fish

Table 13 Threatened fish

Common name	Scientific name	Status
		V
Fish		
Black rockcod	*Epinephelus daemelii*	✓
Australian grayling	*Prototroctes maraena*	✓

Notes: V: Vulnerable

Black rockcod

The black rockcod (*Epinephelus daemelii*) is a large bodied fish within the Serranidae (groupers).The species is found throughout the south-west Pacific and demonstrates high site fidelity within rocky reefs. Part of the reason that the species has undergone decline is due to the species often occupying an individual cave for its entire life-cycle (Department of the Environment, 2014i). Thus, the species is susceptible to localised depletion from recreational and commercial harvest (Fishbase, 2013).

Australian grayling

The Australian grayling (*Prototroctes maraena*) is a slender bodied, diadromous fish that inhabits coastal freshwater and brackish environments (Department of the Environment, 2014j). As adults, they inhabit freshwater streams and pools, with the larvae and juvenile age classes inhabiting coastal and estuarine waters. Given the species' short life-cycle, between year recruitment is highly variable and can undergo large fluctuations due to prevailing conditions. As such, the species can undergoes large, annual fluctuations in population numbers (Jenkins et al., 2012). As well as dramatic population changes in response to environmental stimulus, the species faces a number of ongoing threats including habitat alterations and degradation, competition with introduced species and disease (Department of the Environment, 2014j).

Threatened Sharks

Table 14 Threatened sharks

Common name	Scientific name	Status		
		Cr	V	Mig
Sharks				
Grey nurse shark (east coast population)	*Carcharias taurus*	✓		
Great white shark	*Carcharodon carcharias*		✓	✓
Green sawfish	*Pristis zijsron*		✓	
Whale shark	*Rhincodon typus*		✓	✓

Notes: Cr, Critically Endangered, V: Vulnerable, Mig: Migratory

Grey nurse shark (east coast population)

The grey nurse shark (*Carcharias taurus*) is a large bodied shark from the family Odontaspididae. Born at approximately 100 cm, maturity occurs at 190-195 cm for males and 220-230 cm for females, before reaching a maximum size of approximately 300 cm (Last and Stevens, 2009). Although the species is distributed throughout Australian coastal waters, the largest populations are from sub-tropical and temperate areas throughout eastern and western Australia (Last and Stevens, 2009). The life history of the grey nurse shark makes it particularly susceptible to population decline. For example, the species exhibits a reproductive cycle known as oophagy, where a single pup is born from each uterus following *in utero* cannabilism of siblings. This reproductive strategy results in an extremely low fecundity. Coupled with a gestation of between 9 to 12 months, the productivity of the species is extremely low (Last and Stevens, 2009).

From an ecological perspective the grey nurse shark is susceptible to localised depletion, as aggregations of the species are known from nearshore rocky outcrops (Bansemer and Bennett, 2008). In NSW waters these include Julian Rocks at Byron Bay and Fish Rock at South West Rocks. Although the species does not form a component of any targeted fishery, indiscriminate killing of the species on the east-coast of Australia led the species being protected in NSW in 1984. Given its low productivity and localised vulnerability, the species has never fully recovered and remains critically endangered on the east coast of Australia under the EPBC Act (Department of the Environment, 2014br).

Great white shark

The great white shark (*Carcharodon carcharias*) is a large bodied shark within the family Lamnidae and is currently listed as vulnerable under the EPBC Act (Department of the Environment, 2014bs). Like many other large bodied shark species, the great white shark is susceptible to population decline due its life history characters of slow growth, late maturation and low fecundity (Last and Stevens, 2009). The great white shark is distributed predominantly throughout temperate Australia, with individuals known to undertake migrations into sub-tropical and tropical waters (Bruce et al., 2006). Similar to the grey nurse shark, known aggregations of the great white shark occur in nearshore waters of NSW. The most well-known occurs at Stockton Beach, Newcastle, as this stretch of coastline is inhabited by neonate and juvenile age classes.

Green sawfish

The green sawfish (*Pristis zijsron*) is one of the largest known rays, attaining a reported maximum body size of 700 cm. Like other Pristids, their body shape is shark-like and they display a blade-like rostrum with enlarged lateral tooth-like denticles along the rostrum (Last and Stevens, 2009). This body morphology makes the species extremely susceptible for capture within commercial net and trawl fisheries. Coupled with its conservative life-history, the species has undergone population decline and is currently listed as vulnerable under the EPBC Act (Department of the Environment, 2014bt) .

Along the east coast of Australia, the green sawfish has undergone a large-scale range reduction in southern and central waters. This is highlighted by the NSW Department of Fisheries declaring the animal to be extinct within NSW waters (NSW Department of Primary Industries, 2013).

Whale shark

The whale shark (*Rhincodon typus*) is the largest fish species worldwide and is currently listed as Vulnerable under the EPBC Act. The species attains approximately 15 m and inhabits coastal areas, the pelagic zone and open ocean basins. Due to its body size and solitary nature, little is known of the species biology. However, the species is thought to be highly fecund, producing up to 300 pups which are born at 40 – 50 cm (Last and Stevens, 2009). Heavily fished in parts of its worldwide distribution, within Australia the species does not form a component of any targeted fishery. However, its naturally low abundance and worldwide declines throughout its distribution preclude the species being listed as vulnerable under the EPBC Act (Department of the Environment, 2014bu). The species is known from eastern Australia; however, it remains in low numbers along this coastline, with sightings of the species remaining rare.

Threatened Marine Birds

Table 15 Threatened marine birds

Common name	Scientific name	Status		
		En	V	Mig
Marine birds				
Northern royal albatross	*Diomedea epomophora sanfordi*	✓		✓
Tristan albatross	*Diomedea exulans exulans*	✓		✓
Southern giant-petrel	*Macronectes giganteus*	✓		✓
Gould's petrel	*Pterodroma leucoptera leucoptera*	✓		✓
Chatham albatross	*Thalassarche eremita*	✓		✓
Southern royal albatross	*Diomedea epomophora epomophora*		✓	✓
Wandering albatross	*Diomedea exulans (sensu lato)*		✓	✓
Antipodean albatross	*Diomedea exulans antipodensis*		✓	✓
Gibson's albatross	*Diomedea exulans gibsoni*		✓	✓
White-bellied storm-petrel	*Fregetta grallaria grallaria*		✓	
Northern giant-petrel	*Macronectes halli*		✓	✓
Kermadec petrel (western)	*Pterodroma neglecta neglecta*		✓	
Australian fairy tern	*Sternula nereis nereis*		✓	
Buller's albatross	*Thalassarche bulleri*		✓	✓
Shy albatross	*Thalassarche cauta cauta*		✓	✓
Salvin's albatross	*Thalassarche cauta salvini*		✓	✓
White-capped albatross	*Thalassarche cauta steadi*		✓	✓
Black-browed albatross	*Thalassarche melanophris*		✓	✓
Campbell albatross	*Thalassarche melanophris impavida*		✓	✓

Notes: En: Endangered, V: Vulnerable, Mig: Migratory

Northern royal albatross

The northern royal albatross (*Diomedea epomophora sanfordi*) is a migratory bird that occurs in the coastal and marine aerial habitats south of Brisbane through to Antarctica. Breeding takes

place on Chatham Island, off the coast of Christchurch, New Zealand. In addition, a small population (approximately 28 individuals) breeds at Taiaroa Head, near Dunedin, New Zealand (Department of the Environment, 2014k). Nesting sites have specific attributes; the ground must be flat or gently sloping with depressions, gullies, slopes and vegetation for shelter. Vegetation must also be sparse enough that adults are able to walk through the area. However, clear, exposed areas must be nearby to provide an appropriate 'take-off and landing' space. Adult birds take fish, crustaceans, cephalopods and pelagic tunicates from the surface of the water, and this foraging behaviour makes them particularly susceptible to drowning when taking longline baits (Department of the Environment, 2014k). The northern royal albatross is migratory, although little is known of the exact migration pathways. In a small study of three individuals, Thomas et al. (2010) found that juveniles migrated directly to Chile after fledging.

Tristan albatross

The Tristan albatross (*Diomedea exulans exulans*) is a large albatross with a 3.5 m wingspan. The majority of breeding takes place on Gough Island (several pairs bred on Inaccessible Island), off the coast of South Africa in the South Atlantic Ocean. Breeding is bi-annual, and occurs in colonies of several thousand birds (Marchant and Higgins, 1990). Fledging occurs in January and February (Swales, 1965). The foraging grounds of this species are off the Cape of Good Hope in the Atlantic Ocean (Department of the Environment, 2014l).

Southern giant-petrel

The southern giant-petrel (*Macronectes giganteus*) is the largest petrel, and is an aggressive scavenger and successful predator. It is particularly associated with penguin and seal colonies, which provide an abundant food resource for the southern giant-petrel (Department of the Environment, 2014m). However, it is generally found in low densities across landmasses in Antarctic waters in summer, and is thought to move to areas north of 50 °S in winter (Department of the Environment, 2014m). This species is widespread, but is in rapid population decline, with an estimated population reduction of 20 percent since 1985 (Patterson et al., 2008).

The southern giant-petrel breeds on several islands in the Southern Ocean (Heard Island, Macquarie Island and McDonald Island) and Australian Antarctic Territory (specifically, Giganteus Island, Frazier Island and Hawker Island) (among others) (Department of the Environment and Water Resources, 2006; Patterson et al., 2008). Colonies form on open sloping areas along the coast, often near a steep drop (Department of the Environment, 2014m). Breeding takes place annually, with laying starting in September. Nests are generally simple, and are constructed from vegetation, small stones and small bones (Department of the Environment, 2014m).

Gould's petrel

Gould's petrel (*Pterodroma leucoptera leucoptera*) is a rare small petrel that is endemic to Australian waters (Department of the Environment, 2014n; O'Dwyer et al., 2007). Little is known of the movement, migration and dispersal patterns of this species; however, it is thought that during the non-breeding season, birds move to the north Tasman Sea or east Pacific Ocean (Department of the Environment, 2014n; Marchant and Higgins, 1990; Roberson and Bailey, 1991). Breeding occurs on only two areas – Cabbage Tree Island and the Boondelbah Islands, off the Newcastle coast. Nests are simple, and are generally formed in a depression with little lining (O'Dwyer et al., 2006). Eggs are laid in late November through to early December, with fledging starting in late April (Marchant and Higgins, 1990). Adult petrels forage by surface-seizing, and generally feed on cephalopods and fish (Roberson and Bailey, 1991).

Chatham albatross

The Chatham albatross (*Thalassarche cauta eremita*) is a moderately-sized albatross of the shy albatross complex (Department of the Environment, 2014bv). There is only one known breeding area for this species – The Pyramid, which is a small islet of the Chatham Islands off the east coast of New Zealand (Robertson et al., 2003). While this breeding area is isolated, this species is vulnerable to disturbance (*e.g.* exotic predators have spread to the island). Population recovery would be inhibited by the long generation length of 25 years (Garnett and Crowley, 2000). The Chatham albatross forages in the coastal waters of Tasmania and southern and eastern New Zealand, and there is some evidence to suggest that is undertakes migrations to the coast of South America (Latham et al., 2004; Nicholls and Robertson, 2007).

Southern royal albatross

The southern royal albatross (*Diomedea epomophora epomophora*) is a marine, pelagic albatross that feeds on fish and squid (Marchant and Higgins, 1990). This species has a wide distribution that includes southern Australia (including south-east NSW) (Department of the Environment, 2014o). Breeding takes place on Campbell Island (the primary breeding location) and the Auckland Islands off the south coast of New Zealand (Pizzey and Knight, 1999). Feeding areas for the southern royal albatross are mostly between Western Australia and South America in the Southern Ocean (Marchant and Higgins, 1990). This species nests biennially on sparsely vegetated flat or gently sloping ground of islands with gullies, depressions and vegetation providing shelter. Nearby exposed areas are also required for 'take-off and landing'. Mates couple in November, and the relationship is usually monogamous for life. Eggs are laid in late November, with fledging occurring at around 240 days (Sorensen, 1950). The general migratory pathway is thought to be from the breeding area to South American waters (Marchant and Higgins, 1990). Overwinter areas include New Zealand, south-eastern Australian and Chilean waters, and the southern Indian Ocean (Robertson and Kinsky, 1972).

Wandering albatross

Wandering albatross (*Diomedea exulans* (*sensu lato*)) are well-known for their long wingspan (up to 3.5 m) and extensive circumpolar migrations (Department of the Environment, 2014bw; Imber, 1992). This species undertakes shallow dives and surface-snatching to capture prey (predominately fish, squid, crustaceans and carrion (Clarke et al., 1981; Marchant and Higgins, 1990). Breeding areas are confined to Antarctic and sub-Antarctic islands in the Atlantic Ocean, Indian Ocean and waters off the southern coast of New Zealand (Marchant and Higgins, 1990). Breeding sites are often on marshy areas, but are more generally located on ridges, slopes or hills. Nests are formed on moss terraces amongst tussock grasses, although vegetation must be open to allow access by adult birds (Marchant and Higgins, 1990; Warham and Bell, 1979). Juveniles migrate from their natal grounds to the subtropical Indian Ocean and Tasman Sea (Weimerskirch et al., 2006). Adults undertake circumpolar migrations east (Marchant and Higgins, 1990). However, there are a number of wandering albatross that migrate during the non-breeding season to the coastal waters off Wollongong, south of Sydney (Nicholls and Robertson, 2007).

Antipodean albatross

The Antipodean albatross (*Diomedea exulans antipodensis*) is described as being endemic to Antipodes Island in the sub-Antarctic waters south-east of New Zealand; however, it forages in the south-west Pacific Ocean, Southern Ocean and Tasman Sea (Walker and Elliot, 2006). It is also known to forage off the coast of NSW (Department of the Environment, 2014p). Antipodes Island (south-west of New Zealand) is the major breeding area, although a small colony also nests on Campbell Island (south of New Zealand) (Walker and Elliot, 2006). Nest sites are placed in open, sparse vegetation (*e.g.* amongst shrubs or tussock grasses) on ridges, slopes

or plateaus (Warham and Bell, 1979). This species breeds biennially, with laying commencing in January and fledging starting in late December of that year (Bailey and Sorensen, 1962; Warham and Bell, 1979).

Gibson's albatross

Gibson's albatross (*Diomedea exulans gibsoni*) is a large albatross that closely resembles the wandering albatross. Gibson's albatross is widely distributed between latitudes 30 °S and 50 °S, and is known to forage in oceans off south-east Australia (Department of the Environment, 2014q). Nesting occurs on Adam's Island and Auckland Island off the coast of New Zealand, where breeding sites are often on marshy areas, but are more generally located on ridges, slopes or hills. Nests are formed on moss terraces amongst tussock grasses, although vegetation must be open to allow access by adult birds (Marchant and Higgins, 1990; Warham and Bell, 1979). Adult albatross return to breeding sites in November, and eggs are laid from late December (Carrick and Ingham, 1967), and chicks fledge from mid-November the following year (Tickell, 1968).

White-bellied storm-petrel

The white-bellied storm-petrel (*Fregetta grallaria grallaria*) is a small, polymorphic petrel measuring 20 centimetres in length (Marchant and Higgins, 1990). This species occurs in the tropical and subtropical waters of the Pacific, Indian and Atlantic Oceans, and is known to occur off the coast of NSW (Marchant and Higgins, 1990). It breeds in colonies on small islets and rocks in the Lord Howe Island (north-east of Sydney) and Kermadec Island (north-east of New Zealand) complexes (Hutton, 1991; Marchant and Higgins, 1990; McAllan et al., 2004). Approximately 40 percent of the total global population breeds on Australian territory (Department of the Environment, 2014bx). Breeding commences in late summer, with offspring fledging in May (Hutton, 1991; McAllan et al., 2004). The white-bellied storm-petrel migrates between its breeding areas to the Tasman Sea, Pacific Ocean and Coral Sea (Hutton, 1991; Marchant and Higgins, 1990).

Northern giant-petrel

The northern giant-petrel (*Macronectes halli*) is a large petrel with a wingspan of up to 2.1 m (Department of the Environment, 2014by). Breeding starts in August in sub-Antarctic islands and in South Georgia where it builds cup-shaped nests in sheltered areas of heavy vegetation or rough terrain (Marchant and Higgins, 1990). This species is a scavenger and hunter, and feeds mostly on carrion, seal placentae, crustaceans, cephalopods, fish and other seabirds (Marchant and Higgins, 1990). Adult northern giant-petrels generally remain close to breeding areas year-round; however, juveniles undertake long dispersal events, although these movements are not well-understood (Marchant and Higgins, 1990).

Kermadec petrel (western)

The Kermadec petrel (western) (*Pterodroma neglecta neglecta*) is a pelagic petrel of the Pacific Ocean (Marchant and Higgins, 1990). This species breeds on islands, islets and atolls in the southern Pacific Ocean. Within Australia, the Kermadec petrel nests at Ball's Pyramid (off the coast of Port Macquarie) and Phillip Island, where the breeding season lasts from October through to May (Department of the Environment, 2014bz). This species is generally solitary, and undertakes large-scale dispersal events within the Pacific Ocean (Marchant and Higgins, 1990).

Australian fairy tern

The Australian fairy tern (*Sternula nereis nereis*) is a very small but stocky tern that is generally considered to be gregarious (Higgins and Davies, 1996). This species is known from the coastline around Australia (excluding the Northern Territory), but sightings are concentrated in

Victoria, South Australia, Western Australia and Tasmania (Department of the Environment, 2014r). It is now considered to be extinct in NSW (Department of the Environment, 2014r). The Australian fairy tern nests colonially from October through to February on sparsely vegetated sandy substrate within close proximity to the water. Nests are a simple depression in the ground with some lining (shells and/or vegetation) (Higgins and Davies, 1996).

Buller's albatross

Buller's albatross (*Thalassarche bulleri*) are a small, lightly-built albatross with a wingspan of up to 213 centimetres (Marchant and Higgins, 1990). It inhabits the sub-tropical and sub-Antarctic waters of the southern Pacific Ocean (Marchant and Higgins, 1990). This species breeds in the Chatham, Snares and Solander Islands in New Zealand, but its distribution extends into Australian waters, including off the coast of Sydney (Department of the Environment, 2014s). Buller's albatross generally mate for life, within breeding commencing in December. Eggs are laid in January and February, and offspring fledge in September (Marchant and Higgins, 1990). Buller's albatross feed through surface-seizing and diving; prey is predominantly fish, krill and tunicates (Marchant and Higgins, 1990). Migration and dispersal patterns of Buller's albatross and poorly understood, although there is some evidence that juvenile birds migrate to the Humboldt Current (Marchant and Higgins, 1990).

Shy albatross

The shy albatross (*Thalassarche cauta cauta*) is described as being the largest black-backed albatross with a wingspan of up to 2.56 m (Department of the Environment, 2014ca; Marchant and Higgins, 1990). This species occurs in Australian waters below 25 °S, but is most frequently observed off south-east Australia and Tasmania (Brothers et al., 1997; Hedd et al., 2001). Shy albatross are less oceanic than most species, and are described as being more frequent inshore than offshore (Marchant and Higgins, 1990). Breeding areas are in the Bass Strait and off southern Tasmania (Marchant and Higgins, 1990). The shy albatross breeds annually, with the breeding season lasting from September through to April. Nesting is in conical mounds with some lining (Marchant and Higgins, 1990). It appears that the dispersal of juveniles from the natal site is variable, with fledglings moving to different areas, depending on colony (Department of the Environment, 2014ca; Marchant and Higgins, 1990). While the shy albatross is described as being endemic to Australia (and can be sedentary), it does undertake migrations throughout the southern oceans, from Africa through to South America (Marchant and Higgins, 1990).

Salvin's albatross

Salvin's albatross (*Thalassarche cauta salvini*) are a large, sexually dimorphic albatross with a wingspan of up to 2.56 m (Marchant and Higgins, 1990). This species breeds on the Bounty, Snares and Chatham Island off the south coast of New Zealand, and Crozet Island in the Indian Ocean (Gales, 1998). The foraging area for this species covers much of the southern Pacific Ocean, and it is particularly associated with the Humboldt Current (Marchant and Higgins, 1990). Salvin's albatross are less oceanic than most species, and are described as being more frequent inshore than offshore (Marchant and Higgins, 1990). Nesting occurs on flat or sloping broken terrain with little vegetation or soil (Department of the Environment, 2014cb). Little is known of the breeding biology or migration patterns of this species (Department of the Environment, 2014cb).

White-capped albatross

The white-capped albatross (*Thalassarche cauta steadi*) is thought to be common off the coast of southeast Australia (Department of the Environment, 2014t), and is generally the most abundant albatross off the New Zealand shelf (Department of the Environment, 2014t). However, juveniles are rarely observed in this area, and are more common off the coast of

South Africa and south-east Australia (Marchant and Higgins, 1990). Breeding takes place on vegetated slopes in the Auckland Islands off the south coast of New Zealand (Marchant and Higgins, 1990). Little is known of the breeding biology or migration patterns of this species (Department of the Environment, 2014t).

Black-browed albatross

The black-browed albatross (*Thalassarche melanophris*) is a pelagic, gregarious albatross that occurs throughout Antarctic, sub-Antarctic and sub-tropical waters (Marchant and Higgins, 1990). Breeding occurs on sub-Antarctic and Antarctic islands on rocky islets or vegetated shelves of cliffs or slopes (Marchant and Higgins, 1990). This species nests in columns and pedestals of grass, with laying commencing in October (Department of the Environment, 2014cc). Diet consists mostly of fish, cephalopods and krill, which it captures by snatching from beneath the water surface, or through short dives (Marchant and Higgins, 1990). The black-browed albatross migrates to the continental shelves of South America, South Africa, New Zealand and Australia during the winter months (Marchant and Higgins, 1990).

Campbell albatross

Campbell albatross (*Thalassarche melanophris impavida*) are a sub-species of the black-browed albatross (Department of the Environment, 2014u). The Campbell albatross does not breed in Australian waters, but is known to forage over the continental shelf off NSW, Victoria and Tasmania (Department of the Environment, 2014u). Migration to these areas is thought to occur after the breeding season (Marchant and Higgins, 1990). The only known breeding area for this species is Campbell Island, off the southern coast of New Zealand (Department of the Environment, 2014u; Marchant and Higgins, 1990). Breeding is annual, and commences in late August, with laying starting in late September (Department of the Environment, 2014u).

Threatened Terrestrial Mammals

Table 16 Threatened terrestrial mammals

Common name	Scientific name	Status	
		En	V
Terrestrial mammals			
Spot-tailed quoll (southeastern mainland population)	*Dasyurus maculatus maculatus*	✓	
Southern brown bandicoot (eastern)	*Isoodon obesulus obesulus*	✓	
Large-eared pied bat	*Chalinolobus dwyeri*		✓
Brush-tailed rock-wallaby	*Petrogale penicillata*		✓

Common name	Scientific name	Status	
		En	V
Koala	*Phascolarctos cinereus*		✓
Long-nosed potoroo	*Potorous tridactylus tridactylus*		✓
New Holland mouse	*Pseudomys novaehollandiae*		✓
Grey-headed flying-fox	*Pteropus poliocephalus*		✓

Notes: En: Endangered, V: Vulnerable

Spot-tailed quoll (southeastern mainland population)

The spot-tailed quoll (*Dasyurus maculatus maculatus*) is a carnivorous land-based marsupial. The southeastern mainland population of this species has a distribution that extends from central Queensland down through NSW and Victoria (Department of the Environment, 2014cd). In NSW, spot-tailed quolls are most commonly recorded within 200 km of the coast. Habitat and subsequent population fragmentation is the biggest threat to the persistence of this species. Spot-tailed quolls are nocturnal and rest in dens during daylight hours. Fifty percent of dens are typically made in hollow logs; however, standing tree hollows, caves, burrows and rocky outcrops are also used (Glen and Dickman, 2006). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Southern brown bandicoot (eastern)

The southern brown bandicoot (*Isoodon obesulus obesulus*) occurs in the coastal regions of NSW, Victoria and South Australia. Within NSW, this species is rare, with only two main populations in the:

- Ku-ring-gai Chase and Garigal National Parks north of Sydney
- Far south-east corner of the state (including Ben Boyd National Park, East Boyd State Forest, Nadgee Nature Reserve, Nadgee State Forest, South East Forest National Park and Yambulla State Forest) (NSW Department of Environment and Conservation, 2006)

However, there are also a number of records of this species throughout its known range, including from the north Sydney area (Department of the Environment, 2014ce). The southern brown bandicoot is particularly dependent on dense vegetation. Suitable habitat for this species is recognised as vegetation (native or non-native) with a low (0.2 to 1.0 m) understorey structure of between 50 to 80 percent average foliage density (Department of the Environment, 2014ce). In the Sydney area, grass trees (genus *Xanthorrhea*) are of particular importance as nesting sites (Paull, 1995; Wilson, 2004), although woody debris (Claridge, 1988), rocks and burrows are also used. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Large-eared pied bat

Large-eared pied bats (*Chalinolobus dwyeri*) are moderately sized insectivores. This species was only relatively recently described in 1966, and so the historical and current distribution is poorly understood (Department of the Environment, 2014cf). However, its distribution covers much of central Queensland through to southern NSW. Generally, this species has an uncommon and patchy presence within this distribution, although observations suggest the population is concentrated in the Sydney Basin sandstone escarpments and north-west slopes (Department of the Environment, 2014cf). In NSW, the large-eared pied bat occurs in wet and dry sclerophyll forest, Cyprus pine (*Callitris glauca*) forest, sub-alpine woodland, tall open eucalypt forest with a rainforest sub-canopy and sandstone outcrops. There are only a limited number of known maternity roosts, all of which occur in NSW, as follows:

- a roost in a sandstone cave near Coonabarabran (Pennay, 2008)
- a roost in the Pilliga sandstone and Pilliga Scrub (Department of the Environment, 2014cf)
- a potential roost in the sandstone cliffs near Ulan (Fly by Night Bat Surveys Pty Ltd, 2004)
- a potential roost in an abandoned gold mine bear Barraba (Department of the Environment, 2014cf)

All of these maternity roosts are critical habitat that is essential to the persistence of this species. Although suitable habitat for this species is not present within the small land-based portion of the APX-East corridor, the species may fly over the area during local migrations.

Brush-tailed rock-wallaby

The brush-tailed rock-wallaby (*Petrogale penicillata*) occurs from southern Queensland through to western Victoria. In NSW, there are a large number of known colonies of the brush-tailed rock-wallaby; however, these colonies are highly isolated and therefore vulnerable to extinction (Department of the Environment, 2014cg). This species has very specific habitat requirements of rocky outcrops and slopes, cliff, gorges, boulder piles and rock stacks (Murray et al., 2008; Short, 1982). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Koala

The koala (*Phascolarctos cinereus*) is a moderately-sized arboreal marsupial that feeds predominately on *Eucalyptus*, *Corymbia*, *Angophora* and *Lophostemon* leaves. However, recent research has shown that both food and non-food (shelter) trees are important habitat requirements for the koala (Crowther et al., 2013). In NSW, koalas are most abundant in the North Coast and Central Coast (Department of the Environment, 2014ch). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Long-nosed potoroo

The long-nosed potoroo (*Potorous tridactylus tridactylus*) is a moderately-sized diprotodont that occurs throughout south east Australia. In NSW (Department of the Environment, 2014ci). The population is sparse and of an unknown size and status, but has been assessed as insecure at Tyagarah (Mason, 1997). The long-nosed potoroo is a habitat generalist, but does require dense vegetation for shelter (Bennett, 1987), and requires fungi as an important part of its diet (Claridge et al., 1992). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

New Holland mouse

The New Holland mouse (*Pseudomys novaehollandiae*) is a small, social rodent with a fragmented distribution across its range. This species occurs in south-east Queensland down through NSW, Victoria and into Tasmania. In NSW, the New Holland mouse is known to occur in:

- the Kangaroo Valley
- the Royal National Park (Posamentier and H.F., 1974)
- the Kuringai Chase National Park (Prosser et al., 2007)
- Port Stephens to Evans Head near the Queensland border (Prosser et al., 2007)

Specific habitat requirements include deep top soils and soft substrates suitable for burrow construction (Wilson and Laidlaw, 2003). This species is also highly associated with heathland and vegetated sand dunes (Department of the Environment, 2014cj). Seeds are a large part of the New Holland mouse's diet, and this species is known to play an important ecological role in seed dispersal (Department of the Environment, 2014cj). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Grey-headed flying-fox

The grey-headed flying-fox (*Pteropus poliocephalus*) is a large bat that occurs in eastern Australia. This species is generally highly nomadic in response to the changing availability of food resources (Department of the Environment, 2014ck). However, grey-headed flying fox inhabit Sydney, Brisbane, Melbourne and Newcastle year round. Suitable roosting and foraging sites are required by this species. While the subject of much controversy, grey-headed flying-fox are essential to the pollination and seed dispersal for many native and commercial crops. This species undertakes daily migration to and from roosts, but also undergo seasonal dispersal in response to their foraging requirements. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor. However, the species may flyover the area during localised or broad scale migrations (Department of the Environment, 2014ck).

Threatened Terrestrial Reptiles

Table 17 Threatened terrestrial reptiles

Common name	Scientific name	Status
		V
Snakes		
Broad-headed snake	*Hoplocephalus bungaroides*	✓

Notes: V: Vulnerable

Broad-headed snake

The broad-headed snake (*Hoplocephalus bungaroides*) is a small to medium bodied (50 – 70 cm) snake within the family Elapidae. The species has a restricted range, occurring within an approximate 200 km^2 area within Sydney and surrounds (Department of the Environment, 2014cl). During colder months, the species commonly occurs in rocky outcrops and sandstone crevices, with a habitat shift to woodlands and forests during summer months (Croak et al., 2013). The home range of the broad headed snake occurs within one of Australia's most densely populated areas. Thus urbanisation and loss of habitat are the key threats facing the

species. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Threatened Terrestrial Birds

Table 18 Threatened terrestrial birds

Common name	Scientific name	Status		
		Cr	En	Mig
Terrestrial birds				
Orange-bellied parrot	*Neophema chrysogaster*	✓		✓
Regent honeyeater	*Anthochaera phrygia*		✓	✓
Australasian bittern	*Botaurus poiciloptilus*		✓	
Eastern bristlebird	*Dasyornis brachypterus*		✓	
Swift parrot	*Lathamus discolor*		✓	

Notes: Cr, Critically Endangered, En: Endangered, Mig: Migratory

Orange-bellied parrot

The orange-bellied parrot (*Neophema chrysogaster*) occurs along the coastal margins of south-east mainland Australia and western Tasmania. It is a small member of the grass parrots, and the total population size is estimated at less than 150 individuals. This species undertakes an annual migration from the mainland to Tasmania, with the fly way through the Bass Strait. Breeding occurs in south-west Tasmania only, and nesting takes place in *Eucalypt* hollows from November through to February. In NSW, there are few records of the orange-bellied parrot. Observations of this species at Sydney from the late 18th and early 19th century are likely to be erroneous (McGill, 1960); however, there are recent reports of the orange-bellied parrot in the Sydney region and south (Department of the Environment, 2014cm). Overall, the orange-bellied parrot range is declining (Department of the Environment, 2014cm). The orange-bellied parrot has specialised foraging requirements, and feeds almost exclusively on the seed and fruit of coastal plants (including sedges and salt marsh plants) (Department of the Environment, 2014cm). As a small population with specific critical habitats, the orange-bellied parrot is very susceptible to extinction. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Regent honeyeater

Regent honeyeater (*Anthochaera phrygia*) are a large, distinctive honeyeater that occurs in a patchy distribution throughout south-eastern Australia. One isolated population is located near Cairns in north Queensland (Department of the Environment, 2014cn). Garnett et al. (2010) recently identified the breeding habitats for this species as being:

- south-east Queensland

- the Capertee Valley, central east NSW
- the Bundarra-Barraba region, northern NSW
- the Warrumbungle National Park, Pilliga forests and Mudgee-Wollar region, central north NSW
- the Hunter Valley and Clarence Valley, east NSW
- the Chiltern section of Chiltern-Mountain Pilot National Park, north-east Victoria
- Wangaratta-Mansfield region, Victoria

Of these known breeding areas, the Capertree Valley is the closest to the APX-East corridor. Regent honeyeaters are generally observed in close association with eucalypts bearing heavy loads of nectar (*e.g.* ironbark, box and gums). Nesting occurs in tall, mature eucalypts, and so the presence of remnant vegetation is a key habitat requirement for this species. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Australasian bittern

The Australasian bittern (*Botaurus poiciloptilus*) is a large, generally solitary bird with a scattered, patchy distribution across Australia. In NSW, the Australasian bittern is concentrated around coastal areas and in the Murray Darling Basin. This species is omnivorous, with a diet consisting of invertebrates, reptiles, amphibians, birds, leaves and fruit (Marchant and Higgins, 1990). While generally considered a sedentary species, the Australasian bittern does undertake dispersal events in response to changing prey availability and local conditions (Department of the Environment, 2014co). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Eastern bristlebird

The eastern bristlebird (*Dasyornis brachypterus*) occurs in low, dense vegetation along the south-east coast of Australia, and consists of three geographically distinct populations. While naturally fragmented, these populations are becoming increasingly discontinuous as habitat disturbance further isolates these populations (Department of the Environment, 2014cp). Around Sydney, the central regional population consists of approximately 1500 individuals, which is a significant proportion of the total population. Birds in the Barren Grounds Nature Reserve and at Jervis Bay are of particular importance, as these individuals represent more than 60 percent of the total population of eastern bristlebird (Baker, 1998a, 1998b). The eastern bristlebird is a weak flyer, and does not undertake migration or long-distance dispersal (Department of the Environment, 2014cp). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Swift parrot

The swift parrot (*Lathamus discolor*) is a moderately-sized streamlined parrot that are most commonly observed in small flocks of up to 30 individuals (Department of the Environment, 2014cq). This species undertakes annual migrations from mainland Australia to Tasmania for breeding in the summer months, which is reportedly the longest migration of any parrot in the world (Tzaros, 2002). Their breeding habitat is highly restricted to an area of 500 km^2 on the east coast of Tasmania. In NSW, the swift parrot has important wintering habitat along the Great Dividing Range and the coastline, particularly the coastal plains forests (Swift Parrot Recovery Team, 2001). The most critical over-winter area is the lower Hunter Valley region, north of Sydney. Approximately 200 individuals migrate to this area, which represents 10 percent of the total population. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor. However, given its distribution occurs along eastern Australia, it may fly over the area during migrations.

Threatened Wading Birds

Table 19 Threatened wading birds

Common name	Scientific name	Status	
		En	Mig
Wading birds			
Australian painted snipe	*Rostratula australis*	✓	✓

Notes: En: Endangered, Mig: Migratory

Australian painted snipe

The Australian painted snipe (*Rostratula australis*) is the only rostratulid in Australia. It is generally a solitary wading bird, although flocks do form during breeding (Department of the Environment, 2014cr). This species is most commonly observed in eastern Australia, and remains within or in close proximity to dense vegetation. However, the population is in decline, with reporting rates of Australian painted snipe decreasing by more than 90 percent since the 1950s (Rogers et al., 2005). This species is associated with shallow freshwater wetlands, or temporarily inundated terrestrial areas (Department of the Environment, 2014cr). Breeding habitat is specific, being a shallow wetland with areas of exposed wet mud, dense low cover and canopy cover (Department of the Environment, 2014cr; Rogers et al., 2005). Importantly, nearly all nest records are from or near small islands within these (Department of the Environment, 2014cr; Rogers et al., 2005). Nesting typically occurs in a small scraps or depression in the ground, with little lining (Marchant and Higgins, 1990). Breeding is thought to occur in response to the onset of suitable conditions (*i.e.* wet conditions), rather than during specific seasons (Department of the Environment, 2014cr). The migratory patterns of the Australian painted snipe are poorly understood; however, recent research has indicated that this species may winter in the Queensland tropics (Black et al., 2010). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Threatened Frogs

Table 20 Threatened frogs

Common name	Scientific name	Status
		V
Frogs		
Giant burrowing frog	*Heleioporus australiacus*	✓
Green and golden bell frog	*Litoria aurea*	✓

Notes: V: Vulnerable

Giant burrowing frog

The giant burrowing frog (*Heleioporus australiacus*) is a large bodied anuran frog found within south eastern Australia. True to its name, the species spends the majority of diurnal hours within burrows or under fallen branches or trees (Department of the Environment, 2014cs). Breeding for the species occurs year round, with tracking studies indicating that both males and females spend a large amount of time away from breeding areas (20-250 m) (Penman et al.,

2008). Throughout their home range, they access up to 14 burrows making land based conservation efforts extremely important for the species (Penman et al., 2008). The key threats to the ongoing survival of the species include deforestation, cattle grazing, introduced pests and habitat disturbance (Department of the Environment, 2014cs). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Green and golden bell frog

The green and gold frog (*Litoria aurea*) is a large bodied frog within the family Hylidae. Within Australia, its range extends from the NSW and Queensland border, southward into eastern Victoria. Although the species is vulnerable to extinction under the EPBC Act, it is an invasive species outside the country in New Zealand, New Caledonia and Vanuatu (Bower et al., 2013). Its life history is characterised by nature is due to its high fecundity and fast growth (Bower et al., 2013). Although populations of this species exist in urban areas, including a breeding population known from Sydney Olympic Park, they are not known to occur in the vicinity of the APX-East corridor. Typically, local populations of the green and golden bell frog comprise 20 individuals or fewer (Department of the Environment, 2014ct). Throughout its range, the species faces a number of threats, including urbanisation leading to habitat alterations or removal, habitat fragmentation, disease, predation and reduction in water quality. Although suitable habitat for this species within the small land-based portion of the APX-East corridor, there are no known populations of the species in the vicinity of the project.

Threatened Plants

Table 21 Threatened terrestrial plants

Common name	Scientific name	Status		
		Cr	En	V
Plants				
Seaforth mintbush	*Prostanthera marifolia*	✓		
Sunshine wattle	*Acacia terminalis subsp. terminalis MS*		✓	
	Allocasuarina glareicola		✓	
Nielsen Park she-oak	*Allocasuarina portuensis*		✓	
	Asterolasia elegans		✓	
Omeo stork's-bill	*Pelargonium* sp. *striatellum*		✓	
Spiked rice-flower	*Pimelea spicata*		✓	
Botany Bay bearded greenhood	*Pterostylis* sp. Botany Bay (A.Bishop J221/1-13)		✓	

Common name	Scientific name	Status		
		Cr	En	V
Siah's backbone	*Streblus pendulinus*		✓	
Thick-lipped spider-orchid	*Caladenia tessellata*			✓
Leafless tongue-orchid	*Cryptostylis hunteriana*			✓
Camfield's stringybark	*Eucalyptus camfieldii*			✓
Biconvex paperbark	*Melaleuca biconvexa*			✓
	Pimelea curviflora var. *curviflora*			✓
Magenta lilly pilly	*Syzygium paniculatum*			✓
Glandular pink-bell	*Tetratheca glandulosa*			✓
Austral toadflax	*Thesium australe*			✓

Notes: Cr, Critically Endangered, En: Endangered, V: Vulnerable

Seaforth mintbush

The Seaforth mintbush (*Prostanthera marifolia*) is a small shrub within the family Lamiaceae. It is known only from a single population within the Seaforth area in Sydney, NSW (Department of the Environment, 2014cu). It has only recently been rediscovered as it was believed to be extinct prior to 2001 (Department of the Environment, 2014cu). The threats the species faces include inappropriate fire regimes, habitat degradation, disease and encroachment of exotic grasses. At present, the Seaforth mintbush is listed as critically endangered under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Sunshine wattle

The sunshine wattle (*Acacia terminalis subsp. terminalis MS*) is a small tree growing to 6 m in the family Fabaceae. It is found in open coastal eucalypt woodlands on sandy soil, hilly slopes or shallow rock crevices (Department of the Environment, 2014cv). The sunshine wattle has a restricted range, and is largely confined to the eastern suburbs of Sydney, from Kurnell in the south to North Head, Manly (Benson and McDougall, 1996). At present, the greatest threat to this species is land clearing and urban encroachment. Due to its restricted range and low population size, the specie is listed as endangered under the EPBC act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Allocasuarina glareicola

Allocasuarina glareicola is a small, smooth-barked shrub in the family Casuarinaceae, which grows to approximately 2 m. The species grows on terrestrial alluvial gravels and lateritic soils (Department of the Environment, 2014cw). At present, the species is restricted to a range of approximately 36 km^2 around Castlereagh, north-east of Penrith (Department of the Environment, 2014cw; NSW National Parks and Wildlife Service, 1999). As such, the species is currently listed as endangered under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Nielsen Park she-oak

The Nielsen Park she-oak is a slender shrub in the Casuarinaceae. The species grows to approximately 5 m and has only been recorded naturally from a single headland in Nielsen Park (Department of the Environment, 2014cx). Urbanisation and restricted habitat distributions are therefore the biggest threat to this species. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Asterolasia elegans

Asterolasia elegans is a tall, thin shrub in the family Rutaceae that grows to approximately 3 m high. It is found within sheltered forests on mid to lower slopes adjacent to gullies and valleys. It's distribution is limited to northern Sydney and surrounds, from the Baulkham Hills, Hawkesbury and Hornsby shires (NSW Department of Environment and Heritage, 2012b). In total there are only seven known populations of *A. elegans* known to occur naturally. Throughout its range, competition with exotic species, urbanisation and habitat loss or degradation are key threats facing the species. Currently, it is listed as endangered under the EPBC Act (Department of the Environment, 2014cy) and endangered by the NSW Department of Environment and Heritage (NSW Department of Environment and Heritage, 2012b). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Omeo stork's-bill

Omeo stork's bill (*Pelargonium sp. Striatellum*) is a tufted perennial herb that occurs from coastal northern NSW through to eastern Victoria (Department of the Environment, 2014cz). Two major populations are known from Lake Bathurst, NSW and Lake Omeo, Victoria (Department of Sustainibility Environment Water Populations and Communities, 2011). Due to its low population numbers and recent range restriction through urbanisation and habitat loss, the species is currently listed as endangered under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Spiked rice-flower

The spiked rice flower (*Pimelea spicata*) is a slender, small shrub in the family Thymelaeaceae. The species grows to approximately 50 cm but rarely grows larger than 30 cm (Department of the Environment, 2014da). The species occurs in hilly undulating landscapes such as open woodlands and grasslands. The total number of the population is 4300, with these individuals occurring in two distinct areas at the Cumberland Plain area of western Sydney and the Illawarra Region (Department of the Environment, 2014da). Key threats currently facing this species include habitat loss and fragmentation, weed invasion and exposure to herbicides. Coupled with the species limited distribution and low population size, the species is listed as endangered under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Botany Bay bearded greenhood

The Botany Bay bearded greenhood (*Pterostylis* sp. Botany Bay) is a terrestrial orchid that produces a stem up to 20 cm long. The flower is solitary and translucent green interspersed with dark green veins (NSW Department of Environment and Heritage, 2012c). The species is restricted to the Sydney region where it occurs in isolated populations within Botany Bay National Park and the Kurnell Pennisula (NSW Department of Environment and Heritage, 2012c). Within its known range it occupies level sites on sandy soils derived from sandstone. Currently, the species is exposed to a number of ongoing threats including habitat loss, urban encroachment, variations to fire regimes and competition with exotic species. Couple with its low population size and limited distribution, the species is listed as endangered under the EPBC Act (Department of the Environment, 2014db) and under the NSW threatened species list (NSW Department of Environment and Heritage, 2012c). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Siah's backbone

Siah's backbone (*Streblus pendulinus*) is a large shrub or tree in the family Moraceae, which grows to approximately 6 m. Within Australia, the species is found in warner rainforests and dense forests, particularly in proximity to watercourses (Department of the Environment, 2014dc). It is found along Australia's east coast, from Cape York Peninsula to Milton, south-east NSW (Department of the Environment, 2014dc). The key threats facing this species are cattle grazing and competition from weeds. Currently, the species is listed as endangered under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Thick-lipped spider-orchid

The thick-lipped spider-orchid (*Caladenia tessellata*) is a perennial orchid that produces an annual sprout from an underground tuber. The flowering stem produces a yellow-green flower with marron stripes and suffusions (Department of the Environment, 2014dd). The species is endemic to mainland Australia and typically occurs on or near the coast (Duncan, 2010).

Although little is known of its ecology or biology, the species remains dormant during summer. Weed invasion, altered fire regimes, habitat alterations and grazing are the key threats to the species. Currently, the species is listed as endangered under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Leafless tongue-orchid

The leafless tongue-orchid (*Cryptostylis hunteriana*) is a small terrestrial orchid in the family Orchidaceae. The species lives in partnership with a mycorrhizal fungus, from which it derives its nourishment (Department of the Environment, 2014de). Its known distribution occurs from along the east coast of Australia, from Orbust in Victoria to Tin Can Bay in southeast Queensland. However, the species is only known to occur in NSW from isolated populations, with the most prominent populations occurring from south of Sydney between Bateman's Bay and Nowra (Department of the Environment, 2014de). Key threats facing the species include urban development, competition with weeds, changes to soil condition and altered fire regimes. Currently, the species is listed as vulnerable under the EBPC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Camfield's stringybark

Camfield's stringybark (*Eucalyptus camfieldii*) is a eucalypt in the family Myrtaceae that varies in height from a 4 m mallee-like shrub to a 9 m straggly tree. The species mainly occurs in shallow sandy soils within small scattered stands on sandstone plateaus, ridges and slopes in the

coastal zone (Department of the Environment, 2014df). Although originally known from Wollongong to Gosford, the species is now restricted to very few stands confined to national parks in proximity to Sydney (Department of the Environment, 2014df). The key threats currently facing this species include alterations to fire regimes, habitat clearing and weed invasion. At present, the species is listed as vulnerable under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Biconvex paperbark

The biconvex paperbark (*Melaleuca biconvexa*) is a small to medium sized tree in the family Myrtaceae that reaches 10 m tall. The species occurs in damp habitats such as marshlands, bogs or near streams or low lying areas (NSW Department of Environment and Heritage, 2012d). The species is found only in NSW, with scattered populations occurring from Jervis Bay through to the Gosford-Wyong area (NSW Department of Environment and Heritage, 2012d). Key threats facing the species include clearing of habitats, urbanisation, invasive weeds and ecosystem alterations. Currently the species is listed as vulnerable under the EPBC Act (Department of the Environment, 2014dg) and the NSW threatened species list (NSW Department of Environment and Heritage, 2012d). Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Pimelea curviflora *var.* curviflora

Pimelea curviflora var. *curviflora* is a small erect, open shrub in the family Thymelaeaceae, which grows to approximately 40 cm. The species occurs on ridgetops and upper slopes in open forests and woodlands on sandstone derived soil (Department of the Environment, 2014dh). Its distribution is limited to the coastal areas surrounding Sydney between Sydney and Maroota (NSW Department of Environment and Heritage, 2012e). Recently, a new population was detected in southern NSW at Shellharbour (Department of the Environment, 2014dh). The key threats facing the species include habitat loss, habitat degradation and grazing by introduced fauna. At present, the species is listed as vulnerable under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Magenta lilly pilly

The magenta lilly pilly (*Syzygium paniculatum*) is a moderately tall rainforest species in the family Myrtaceae. The species can reach approximately 15 m, but is more common between 3 m to 8 m (Department of the Environment, 2014di). The species is endemic to NSW, occurring in rainforests and sandy soils such as coastal dune areas (NSW National Parks and Wildlife Service, 2001). It is known from a small number of widely scattered populations from Forster to Jervis Bay, with a total population of between 760-2600 mature plants (NSW Department of Environment and Heritage, 2011). Identified threats facing this species include alterations to fire regimes, land clearing, grazing in proximity to creek lines and weed invasion. Currently, the species is listed as vulnerable under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Glandular pink-bell

The glandular pink-bell (*Tetratheca glandulosa*) is a small shrub in the family Tremandraceae, which grows to approximately 20 to 50 cm in height (Department of the Environment, 2014dj). It is found in shale-sandstone transition areas along ridgetops, upper-slopes and mid-slope sandstone beaches (NSW Department of Environment and Heritage, 2013a). The species is endemic to NSW, and is distributed within 6,174 km^2 between Yengo National Park (Central Coast Region) and Lane Cover River National Park (Sydney). It is estimated that there are 11,000 mature plants (Hogbin, 2002). Although this species was identified from the protected

matters search, the species was recently delisted for protection from the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Austral toadflax

The Austral toadflax (*Thesium australe*) is a yellowish-green herb in the family Santalaceae, which grows to 50 cm. It is distributed along the east coast of Australia from the Bunya Mountains in Queensland to north-eastern Victoria (Department of the Environment, 2014dk). The Austral toadflax is semi-parasitic on certain species of grass (such as Kangaroo Grass), and occurs over a wide range of altitudes in subtropical, temperate and subalpine climates (Department of the Environment, 2014dk). Although the species has a wide distribution, it is only found in small scattered populations throughout the state, particularly the northern and southern regions (NSW Department of Environment and Heritage, 2013b). The predominant threats to the species include changes to fire regimes, grazing, urbanisation and weed invasion (NSW Department of Environment and Heritage, 2013b). Currently, the species is listed as vulnerable under the EPBC Act. Suitable habitat for this species is not present within the small land-based portion of the APX-East corridor.

Other Marine Flora and Fauna

The Protected Matters Report for the APX-East corridor (and 10 km buffer area) also identified a number of marine species that are protected under the EPBC Act, but not classed as matters of national environmental significance. These species included a further 26 marine mammals, one terrestrial bird, one marine bird, nine wading birds, one snake and 22 fish in addition to those already described. These species are listed in the Protected Matters Report available in Appendix A.

Additional Marine Mammals

The 26 marine mammals listed in the Protected Matters Report can be broadly divided into the following groups:

- Two seal species (family Otariidae, genus *Arctocephalus*)
- Two sperm whale species (family Physeteroidea, genus *Kogia*)
- One baleen whale species (family Balaenopteridae, genus *Balaenoptera*)
- Seven toothed whale species (family Ziphiidae, genera *Berardius, Ziphius* and *Mesoplodon*)
- 14 oceanic dolphin species (family Delphinidae, genera *Delphinus, Stenella, Steno, Tursiops, Grampus, Feresa, Globicephala, Lissodelphis, Peponocephala* and *Pseudorca*)

Likelihood of occurrence

The species listed above may occur in the project footprint. Many are migratory with movement patterns unknown or poorly understood (e.g. sperm whales). Suitable habitats exist within the APX-East corridor. However, these are not likely to form key habitats or core distributions for marine mammals.

Additional Birds

A further 11 additional birds were listed as marine in the Protected Matters Report. All of these species can be described as wading birds of coastal, estuarine and freshwater habitats, with the exception of the great skua (*Catharacta skua*) and the osprey (*Pandion haliaetus*).

Likelihood of occurrence

Both species are likely to occur in the APX-East corridor, given their wide distribution and occurrence in coastal NSW waters.

Additional Reptiles

Only one additional reptile, the yellow-bellied seasnake (*Pelamis platurus*), was listed as potentially occurring within the cable protection zone. This small seasnake is the most broadly distributed of the seasnakes, and is a slender species with distinctive yellow and black markings (Department of the Environment, 2014dl). While this species most commonly inhabits coastal and inshore waters, it is described as being the most pelagic of the sea snakes (Karthikeyan and Balasubramanian, 2007).

Likelihood of occurrence

The yellow-bellied seasnake may occur in the APX-East corridor. Although suitable habitats are found within the project vicinity, the core distribution for the species does not overlap the project.

Additional Fish

All the additional 22 fish species listed under the EPBC Act were pipefish, seadragons and seahorses (family Syngnathidae). This family generally inhabits coastal waters with diverse benthic structure (*e.g.* seagrasses, coral reefs *etc.*) (Foster and Vincent, 2004). The coastal waters off Sydney are described as an ecotone where tropical waters mix with temperate waters. The marine habitats around Sydney include rocky reefs, rock pools, artificial habitats, mangroves and seagrass meadows which provide suitable habitat for a diverse range of fish species (approximately 600 species (Booth, 2010)). Booth (2010) specifically refers to the Sydney region as a region that encompasses a globally-high diversity of syngnathids, and identifies the weedy seadragon (*Phyllopteryx taeniolatus*) (listed in the EPBC search results) as being endemic to the Sydney and Jervis Bay region.

Likelihood of occurrence

Syngnathids may occur in the APX-East corridor. However, as these species are found predominantly among benthic habitats with high rugosity (e.g. rocky reefs, sea grass beds), suitable habitats are lacking within the APX-East corridor.

Sensitive Time Windows

Windows of ecological sensitivity for environmental values identified within the APX-East corridor are summarised in Table 22.

Table 22 Summary of sensitive time windows within the APX-East corridor

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Survey & cable laying												
Threatened species												
Blue whale					Migration to/from feeding areas to calving/wintering areas. Migration poorly understood in this species.							
Southern right whale					Annual migration from summer feeding grounds (in Antarctic waters) to tropical breeding grounds, returning by late spring.							
Humpback whale					Annual migration from summer feeding grounds (in Antarctic waters) to tropical breeding grounds, returning by late spring. Calving may take place along the NSW coast.							
Loggerhead turtle	May be present as a transient visitor to the area. Breeding does not occur in the region.											
Leatherback turtle	May be present as a transient visitor to the area. Breeding does not occur in the region.											
Green turtle	May be present as a transient visitor to the area. Breeding does not occur in the region.											
Hawksbill turtle	May be present as a transient visitor to the area. Breeding does not occur in the region.											
Flatback turtle	May be present as a transient visitor to the area. Breeding does not occur in the region.											
Black rockcod	Unlikely to be present as habitat within APX-East corridor is generally unsuitable.											
Australian grayling	Juveniles and/or larvae may be present throughout year.											
Grey nurse shark	May be present throughout the year.											
Great white shark	Likely to be present throughout the year.											
Green sawfish	Extinct in NSW.											
Whale shark	May be present as a transient visitor to the area. May also breed in area, but biological data is limited for this species.											
Marine threatened	Marine threatened birds may be present and foraging throughout the year. No known breeding areas are within or near to the											

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
birds	APX-East corridor.											
Migratory species												
Migratory marine mammals	May be present as a transient visitor to the area.				A number of species undertake an annual migration from summer feeding grounds (in Antarctic waters) to tropical breeding grounds, returning by late spring.							May be present as a transient visitor to the area.
Migratory sharks	May be present as a transient visitor to the area. However, lamnids (e.g. great white and makos) likely to occur throughout the year.											
Migratory marine birds	May be present as a transient visitor to the area.				A number of species undertake an annual migration from southern waters to tropical/temperate wintering grounds, returning by late spring.							May be present as a transient visitor to the area.

	Survey activities, HDD and cable laying will occur throughout the year, and are expected to run for a period of 195, 90-120 and 45 days, respectively
	Peak period of activity – presence reliable and predictable
	Lower level of abundance/activity/presence
	Activity not known to occur

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