

APPENDIX

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TERRESTRIAL ECOLOGY IMPACT ASSESSMENT REPORT (UMWELT AUSTRALIA)



GHD Pty Ltd

Assessment of Terrestrial Ecology, Proposed Extension of Shipping Channels, Port of Newcastle

August 2003

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

There is an increasing demand for port facilities within Newcastle Harbour. Waterways is therefore seeking to ensure that there is a sufficient supply of serviceable port land available to meet future demand. The South Arm of the Hunter River has been identified as the most suitable location for port expansion. The development of port facilities in this location will be dependent upon the provision of a dredged navigation channel, swinging basin and berthing trenches designed to accommodate Panamax and Cape Class vessels.

The proposed dredging will be undertaken over a period of approximately two years and will extend approximately three kilometres east from the Tourle Street Bridge to just south of the intersection of Cormorant Road and Egret Street. Dredging would involve the beds and banks of the South Arm below the high water mark.

Excavation for the proposed swing basin will impact on land above the high water mark on both banks of the South Arm. The swing basin will be located approximately 200 metres east of the Tourle Street Bridge, and construction will involve removal of a portion of the OneSteel site on the south bank, and removal of an area of mangrove forest on the north bank. The remainder of the land on the north bank between the Tourle Street Bridge to just south of the intersection of Cormorant Road and Egret Street will be altered for industrial purposes.

The BHP closure area, located on the southern shore of the South Arm, is proposed for dredge spoil handling and containment activities. Contaminated soft silty clays will be dewatered en route to and within a holding facility on this site. Remediation of these contaminated sediments will be conducted on site.

1.2 PROJECT AREA

The proposed dredging area is located to the immediate north of Newcastle, on the southern side of Kooragang Island (**Figure 1.1**). The project area for this terrestrial flora and fauna assessment is the piece of land extending approximately 3 kilometres east from the Tourle Street Bridge to just south of the intersection of Cormorant Road and Egret Street, along the shoreline of the South Arm of the Hunter River (**Figure 1.2**). The land has been assessed from the edge of Cormorant Road to the high water mark. The impact of the proposal on birds utilising the South Arm has also been addressed in this report. The Ecology Lab Pty Limited has authored an assessment of the impact of the proposal on the ecology below the high water mark.

This report also assesses the flora and fauna impacts of the proposal on two sites located on the south bank of the South Arm: the BHP closure area, which is the site proposed for dredge spoil handling and containment; and a portion of the OneSteel site proposed to be excavated for construction of the swing basin (**Figure 1.2**).

The original conformation of the area involved a broad expanse of the South Arm of the Hunter River between the mainland, Dempsey Island and Ash Island. For the greater part of the length of the project area, this expanse of river was intersected by the eastern sector of Spit Island. Reclamation works were undertaken by the BHP Company Limited during the second half of the twentieth century. Further developments in and about the project area involved the expansion of the BHP Steelworks and its peripheral effects. Prior to 1950, the BHP Company Limited had planned the westward extension of the existing plant, involving an ambitious plan of reclamation.

There is no evidence to suggest that the southern shoreline was ever used for a purpose other than rural/grazing and, in its original configuration, the land was low-lying on mud flats susceptible to flooding and subject to tidal influence. Easterly of the location of the projected swing basin, on the southern side of the South Arm of the Hunter River, the bank is almost entirely artificial. For a full discussion of the historical background of the project area refer to the Historical Archaeology Assessment by Umwelt.

1.3 PURPOSE OF THIS DOCUMENT

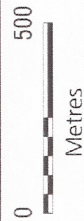
This flora and fauna assessment has been prepared by Umwelt to provide information about the potential impact of the proposal on terrestrial native flora and fauna occurring in the project area. The assessment also addresses potential impacts on any threatened species that may occur in, or in the general vicinity of the project area.

The objectives of the terrestrial flora and fauna assessment were to:

- record the flora and fauna communities in the project area;
- identify any threatened or regionally significant flora and fauna, particularly those listed under the *Threatened Species Conservation Act 1995* (NSW) and the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth);
- assess the impact that the proposed dredging of the South Arm of the Hunter River would have on the flora and fauna communities recorded in the project area; and
- provide management recommendations to minimise flora and fauna impacts associated with this proposal.



FIGURE 1.1
Locality Map

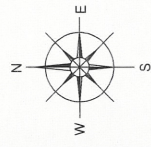


Legend

Terrestrial Ecology Project Area

Note: Refer to Figure C.1 of EIS Main Text for proposed dredging area and location of Swing Basin.

FIGURE 1.2
Project Area



2.0 SURVEY METHODS

2.1 FLORA

Prior to the commencement of field studies, a search of the National Parks and Wildlife Service (NPWS) Atlas of NSW Wildlife database was conducted for the area within a 10 kilometre radius of the project area, to identify threatened flora species known to occur in the local area (refer to **Section 3.5**). A review of literature addressing local flora was also completed, to identify general vegetation communities.

The flora field surveys were undertaken on the 19 November and 3 December 2002. Five walking transects were undertaken throughout the project area. These walking transects were conducted to determine species composition and the level of disturbance of the vegetation, to identify any threatened flora species occurring in the project area, and to assess habitat quality. The walking transects were between approximately 50 metres and 200 metres in length (refer to **Figure 2.1**).

Three 20 metre x 20 metre vegetation survey plots were completed in randomly selected areas within the project area (refer to **Figure 2.1**). Within each of these 20 metre x 20 metre plots, ten 1 metre x 1 metre quadrats were assessed to gather information about species abundance and cover. The information was recorded on standard survey sheets. Each of the species occurring in the larger plot areas was recorded. Samples of all unknown species were collected in the field and were pressed and dried for later identification. Any unidentified plant species were sent to the Royal Botanic Gardens in Sydney for identification.

In addition, aquatic vegetation surveys were completed at several points in the project area (refer to **Figure 2.1**). During these surveys aquatic vegetation and fringing vegetation such as rushes were recorded, and community composition, structure, and species abundance were noted. As with the terrestrial vegetation survey, samples of all unknown species were collected for later identification.

Vegetation communities were classified according to Specht *et al.* (1974 cited in McDonald *et al.* 1990) (refer to **Section 3.2**). During flora surveys information was gathered to generally describe habitat quality and identify evidence of past disturbance of the project area. A flora species list for the project area is provided as **Appendix 1**.

2.2 FAUNA

Prior to the commencement of field studies, a search of the NPWS Atlas of NSW Wildlife database was conducted for the area within a 10 kilometre radius of the project area, to identify fauna species known to occur in the local area. A review of literature addressing local fauna was also undertaken, enabling a list of threatened species potentially occurring in the area to be compiled (refer to **Section 4.6**).

Survey methods were designed to include appropriate techniques to identify any threatened species that could potentially occur in the project area. The field fauna surveys were conducted in calm and mild to warm weather conditions on the afternoons and evenings of 19 November, 3 and 11 December 2002. A fauna species list for the project area is provided as **Appendix 2**.

2.2.1 Birds

2.2.1.1 Diurnal Birds

Diurnal bird surveys were undertaken during the afternoon and evening on 19 November and 3 December 2002 in dry, calm and warm conditions (**Figure 2.1**). Surveys were conducted in mangroves, saltmarsh, waterbody habitat, grassland, and native plantings in order to assess species diversity across the range of habitats available within the project area. The surveys involved walking slowly through the project area, with regular stops at locations shown on **Figure 2.1**. Species were identified from characteristic calls and by observation, using 10 x 40 binoculars. Each survey lasted 20 to 30 minutes, with two observers. Bird surveys were conducted for a total of three person hours.

Opportunistic observations were recorded during other aspects of the field survey, particularly during vegetation surveys.

2.2.1.2 Nocturnal Birds

Owls were targeted during spotlighting transects undertaken throughout the project area on 3 December 2002 between 8.30 pm and 10.00 pm. Owl call playback was not undertaken due to the small size of the project area, the close proximity to the traffic noise on Cormorant Road, and the lack of large or hollow-bearing trees suitable for roosting and nesting. The project area was examined for suitable hollows, owl whitewash and regurgitated pellets.

2.2.2 Mammals

Newcastle City Council does not have flora and fauna survey guidelines, and therefore the Lake Macquarie City Council guidelines were consulted for this assessment (Forest Fauna Surveys and Eastcoast Flora Surveys, 2001). The guidelines require small mammal trapping to be undertaken; however, the small size of the study area, its highly disturbed vegetation, its severe lack of native vegetation communities, and its close proximity to Cormorant Road significantly reduces the potential for small mammals to occur. For these reasons no small mammal trapping was undertaken; however, ground-dwelling and arboreal mammals were targeted during the spotlighting survey, and assessment of potential habitat was made.

Spotlighting transects were conducted on 3 December 2002 for a total of three person hours (**Figure 2.1**). The transects were completed entirely on foot using a 50 watt Lightforce hand-held spotlight, between 8.30 pm and 10.00 pm. Weather conditions comprised a dry, calm and mild night with a temperature of approximately 17°C. Ground-dwelling fauna, arboreal fauna and megachiropteran bat species were targeted during the spotlighting survey, with time also taken to listen for vocalisations by mammals, birds and frogs.

To identify microchiropteran bats in the project area, an Anabat II echolocation detector survey was undertaken for 1.5 hours between 8.30 pm and 10.00 pm on 3 December 2002. The Anabat II system was developed by Titley Electronics, Ballina NSW. Echolocation calls were recorded onto tape for subsequent computer analysis by Glenn Hoyer of Fly by Night Bat Surveys Pty Limited. The Anabat system was left in mangrove habitat for 45 minutes of stationary recording, and then taken on a walking transect for a further 45 minutes throughout the rest of the project area (**Figure 2.1**).

Care was taken during all fauna surveys and during the vegetation surveys to check trees for scratch marks and sap incisions and to search for scats.



Legend

- Walking Transect
- Vegetation Survey Plot
- Aquatic Vegetation Survey/Amphibian Search
- Bird Survey Point
- Spotlight and Anabat Transect
- Reptile Search



FIGURE 2.1
Survey Methods

2.2.3 Herpetofauna

Targeted diurnal searches for reptile and amphibian species were conducted in likely habitat areas throughout the project area between 3.00 pm and 7.00 pm on 19 November and 3 December 2002 (**Figure 2.1**). Each search was undertaken by two personnel in an area of approximately 0.5 hectares for 15 to 20 minutes, resulting in a total sampling effort of approximately 1.5 diurnal person hours. During each search, likely microhabitats were examined, such as under rocks, logs, tree bark, ground litter and in wet soak areas. Opportunistic observations of reptile and amphibian species made during all aspects of field studies were recorded.

Nocturnal amphibian surveys targeting the threatened Green and Golden Bell Frog were undertaken on the nights of 3 and 11 December 2001 between 7.00 pm and 10.00 pm. The night of 3 December was dry, calm and mild, whereas 11 December was a warm and humid night following two days of rain. Next to the freshwater swamp, the call of the Green and Golden Bell Frog was played through a loud-hailer, followed by five minutes of quiet listening and searches of swamp vegetation and surrounding vegetation with low watt hand-held torches (**Figure 2.1**). This process was repeated for one person hour on 3 December and six person hours on 11 December. Conditions on the night of 11 December were ideal for observing or hearing Green and Golden Bell Frogs, as this species usually breeds in summer when conditions are warm and wet.

3.0 FLORA OF THE PROJECT AREA

3.1 REMS MAPPING

Three vegetation communities described under the Regional Environmental Management Strategy (NPWS, 2000) have been identified in the vicinity of the project area. The three communities are the Freshwater Wetland Complex, Swamp Oak - Rushland Forest and Mangrove Estuarine Complex.

Freshwater Wetland Complex occurs in low-lying areas permanently or periodically inundated by fresh water. Structurally, this community can range from open water with aquatic herbs, through closed sedgeland, to low woodland with a sedge understorey in areas only periodically inundated or on swamp margins. The community is very variable with different individual or paired species almost completely dominating depending on localised conditions. The most characteristic feature of this community is the very dense understorey dominated by rushes, sedges and aquatic plants. These can include *Ludwigia peploides* subsp. *montevidensis*, *Eleocharis sphacelata*, *Paspalum distichum*, *Juncus usitatus*, *Typha orientalis*, *Persicaria decipiens* and *Azolla pinnata*. Along swamp margins the improved drainage enables emergent trees to merge with the sedge layer. Where this is the case the most common species found are *Melaleuca styphelioides*, *Casuarina glauca*, *Melaleuca linariifolia* and occasionally *Eucalyptus tereticornis*.

Swamp Oak - Rushland Forest occurs in low-lying areas and along coastal lagoon fringes where brackish-saline groundwater or periodic inundation by saline tidal waters exerts a strong influence on the range of species present. The low forest canopy ranges from moderate to open depending on the relative abundances of *Casuarina glauca* and *Melaleuca quinquenervia*. This community is often characterised by monospecific stands of Swamp Oak. In other areas where the saline influence is less pronounced, canopy species might include *Melaleuca ericifolia*, *Melaleuca quinquenervia*, *Eucalyptus robusta* and *Eucalyptus tereticornis*. Mid-storey vegetation is sparse and often absent, although when present it is usually characterised by tall reeds and rushes (2 to 3 metres) such as *Phragmites australis* and *Cladium procerum*. The dense ground layer is characterised by salt tolerant rushes, grasses and herbs including *Baumea juncea*, *Juncus kraussii* subsp. *australiensis*, *Sporobolus virginicus* and *Apium prostratum*. Where aerial photograph interpretation has identified open rushlands comprising *Phragmites* spp. these have been mapped as a sub unit of this community.

Swamp Oak – Rushland Forest is widespread along lake foreshores and tributaries of the coastal plain. Examples occur on Tuggerah Lakes, Lake Macquarie and Wamberal Nature Reserve.

Mangrove Estuarine Complex occurs on intertidal mudflats, saltwater estuaries and along tidal river edges. It encompasses a broad range of structural forms from bare mud or saltmarshes on mudflats, to low closed Mangrove forest. Bare mudflats are found in areas of recently deposited or reworked tertiary sediment, and are characterised by an almost total absence of vascular plants. Saltmarsh occurs on mudflats often in conjunction with Mangroves, and tolerates higher saline conditions than Mangroves. This variation is often found in landward depressions behind Mangroves where still shallow water and high evaporation rates result in increased relative salt content. Saltmarsh is primarily characterised by *Sarcocornia quinqueflora* subsp. *quinqueflora*, however in less saline conditions *Zoysia macrantha*, *Sporobolus virginicus*, *Triglochin striatum*, *Suaeda australis*, *Samolus repens* and *Juncus kraussii* subsp. *australiensis* commonly occur. Where Mangroves occur, they may range structurally from scattered small trees over saltmarsh to low closed forest. There are two often co-occurring species of Mangrove in the region: *Avicennia marina* subsp. *australasica* and *Aegiceras corniculatum*. *Aegiceras corniculatum* prefers less saline conditions and therefore may extend further up tidal rivers.

3.2 VEGETATION COMMUNITY DESCRIPTION

3.2.1 Modified Grassland

The majority of the project area supports a Modified Grassland community which is mowed, and highly disturbed by vehicle access and rubbish dumping. The community consists of native and exotic grasses and herbaceous and woody groundcover species. There is a high proportion of weed species in the community, including Fireweed (*Senecio madagascariensis*), Cobbler's Pegs (*Bidens pilosa*) and Bitou Bush (*Chrysanthemoides monilifera* ssp. *rotundata*). Dominant species in the community include African Lovegrass (*Eragrostis curvula*), *Phalaris aquatica*, Wire Grass (*Aristida* sp.), and Kikuyu (*Pennisetum clandestinum*).

Near the shoreline of the Hunter River, species tolerant of salt are more common, and the dominant species include: Coastal Pigface (*Carpobrotus glaucescens*); American Pennywort (*Hydrocotyle bonariensis*); and Beach Primrose (*Oenothera drummondii*).

Due to the summer timing of the vegetation survey, in a period of drought, it is likely that the species composition observed differs from that found in wetter times. However, it is highly unlikely that any threatened species would occur in this disturbed community at any time.

3.2.2 Plantings of Native Species

Australian natives have been planted in mixed clumps within the Modified Grassland community, both along Cormorant Road as screens, and along the back of the shoreline. The tallest stratum of these plantings (to 10 metres high) consists of Coastal Banksia (*Banksia integrifolia*), River Red Gum (*Eucalyptus camaldulensis*), Coastal She-Oak (*Casuarina equestifolia* subsp. *incana*) and Umbrella Pine (*Pinus pinea*). The shrub layer (to 4 metres high) consists of Lace Myrtle (*Melaleuca armillaris*), *Melaleuca nesophila*, Coastal Wattle (*Acacia longifolia* subsp. *sophorae*), Willow Wattle (*Acacia saligna*) and Coastal Tea-tree (*Leptospermum laevigatum*). These species are all native to Australia, but have been introduced to the project area for aesthetic purposes.

3.2.3 Mangrove Forest

The Mangrove Forest is located along the shoreline of the western section of the project area as indicated in **Figure 3.1**. The area of Mangrove Forest in the project area is approximately 8.6 hectares, which is equivalent to 0.50% of the area of mangrove in the lower Hunter River, and 1.36% of the area of mangrove on Kooragang Island, as mapped in 1994 (Williams *et al.*, 2000). The width of the Forest is approximately 115 to 140 metres (Ecology Lab Pty Limited, 2003). The Forest is composed of densely-growing Grey Mangroves (*Avicennia marina* subsp. *australasica*) and the occasional River Mangrove (*Aegiceras corniculatum*).

A few scattered juvenile mangroves are located along the shoreline of the remainder of the project area.

3.2.4 Saltmarsh Vegetation

The Saltmarsh Vegetation in the project area is located behind the Mangrove Forest, at a distance of approximately 70 metres to 90 metres from the river (**Figure 3.1**). The area of Saltmarsh Vegetation in the project area is approximately 1.3 hectares, which is equivalent to 0.19% of the area of saltmarsh in the lower Hunter River, and 0.30% of the area of saltmarsh on Kooragang Island, as mapped in 1994 (Williams *et al.*, 2000). The community is dominated by the samphire *Sarcocornia quinqueflora* and bushes of *Suaeda australis*. Sand



Legend

- Plantings of Native Species
- Wetland Vegetation
- Saltmarsh Vegetation
- Mangrove Forest

- Modified Grassland

Umwelt (Australia) Pty Limited
Source: GHD Pty Ltd

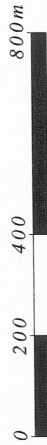


FIGURE 3.1
Vegetation Communities

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Couch (*Sporobolus virginicus*) and Coastal Pigface (*Carpobrotus glaucescens*) are also common species.

3.2.5 Freshwater Swamp Vegetation

The freshwater swamp located in the western part of the project area contains emergent and fringing vegetation (see **Figure 3.1**). The area is dominated by the Spiny Rush (*Juncus acutus*), the Common Reed (*Phragmites australis*) and Cumbungi (*Typha orientalis*).

At the time of survey, the swamp lacked standing water, and therefore no aquatic flora species were identified. During periods of more rainfall, it is expected that common aquatic species would be found in this swamp.

3.3 CONSERVATION SIGNIFICANCE

The conservation significance of the vegetation recorded within the project area is generally considered low, as no naturally-occurring remnant vegetation was recorded, due to the “reclaimed” nature of the area. The project area is highly disturbed by vehicle access, mowing, and rubbish dumping.

However, saltmarsh and mangrove vegetation is important in both a local and regional context, due to the extensive clearing and alteration of these communities that has occurred as a result of coastal development in the last hundred years.

Mangrove habitat is currently expanding in area in the Hunter Estuary and along most of the NSW coast, due to a combination of factors including increased sedimentation, sea-level rise, and legal protection against unauthorised removal. Between 1954 and 1994, the area of mangrove in the lower Hunter River increased by 400 hectares (31%), and increased on Kooragang Island by 20% (Williams *et al.*, 2000). Significant areas of mangrove are now protected within the Kooragang Nature Reserve.

The removal of mangroves under the proposal will require a permit from NSW Fisheries in accordance with S205 of the *Fisheries Management Act 1994* under which mangroves are protected.

Saltmarsh habitat is currently not similarly protected from clearance under legislation, and yet is recognised as a valuable habitat, especially for migratory waders. Saltmarsh areas have decreased markedly in the last few decades, as illustrated by Williams *et al.* (2000) who found that the area of saltmarsh within the lower Hunter River decreased by 1,428 hectares (67%) between 1954 and 1994. On Kooragang Island, 508 hectares (55%) of saltmarsh was lost in the same time period (Williams *et al.*, 2000). Significant areas of saltmarsh are now protected within the Kooragang Nature Reserve.

3.4 THREATENED FLORA SPECIES

No threatened flora species were identified during field investigations in the project area.

3.5 LIKELIHOOD OF OCCURRENCE OF THREATENED FLORA

Seven threatened flora species are known to occur in the vicinity of the project area. Six of these species are considered unlikely to occur in the project area, as potential habitat for these species is generally limited. A list of the threatened flora species recorded within a 10 kilometre radius of the project area is presented in **Table 3.1** (DLWC, 1999; NPWS Atlas

of NSW Wildlife). Included in the table is an indication of each species' likelihood of occurrence within the project area, and whether assessment under Section 5A of the *Environmental Planning & Assessment Act, 1979* (EP&A Act) is required.

Table 3.1 – Likelihood of Occurrence of Threatened Flora

Species	Habitat Requirements	Likelihood of Occurrence
Heart-leaved Stringybark <i>Eucalyptus camfieldii</i>	Tree or mallee to 10 metres high, but often less. Rare and localised, in coastal scrub heath on sandy soils on sandstone, often of restricted drainage, from Gosford to Royal National Park.	No woodland or heath communities are present in the project area, and the substrate is fill. The species is not expected to occur in the project area, as preferred habitat is not present. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Parramatta Red Gum <i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	A small tree 5-15 metres high, bark smooth (not shedding cleanly), white or grey, shedding in large plates or flakes. Locally frequent, in dry sclerophyll woodland on sandy soils in low, often wet sites. Range: Tomago to Kurri Kurri.	No woodland exists in the project area. The species is not expected to occur in the project area, as preferred habitat is not present. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Double Tail <i>Diuris praecox</i>	Small terrestrial orchid with yellow flowers found on hills and slopes of coastal and near-coastal dry sclerophyll forests. Flowers July to early September. Currently know distribution is from Ourimbah to Nelson Bay. Recorded in Glenrock State Recreation Area.	No dry sclerophyll forest exists in the project area. The species is not expected to occur in the project area, as preferred habitat is not present. Therefore assessment under Section 5A of the EP&A Act is not warranted.
<i>Rulingia prostrata</i>	Prostrate shrub forming dense mats 30 cm to 50 cm across and up to 5 cm high, sparsely sprinkled with stellate hairs. Fruits spring to summer. Found mainly in gullies along the escarpment, south from Picton Lakes.	No gullies are located in the project area. The species is not expected to occur in the project area, as preferred habitat is not present. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Black-eyed Susan <i>Tetratheca juncea</i>	A prostrate shrub with leaves up to 1 metre long with distinctive pink flowers. The species is typically found on slopes with a southerly aspect, often in open forest dominated by <i>Angophora costata</i> , <i>Corymbia gummifera</i> , <i>Eucalyptus haemastoma</i> and <i>Eucalyptus capitellata</i> . It also occurs in sandy, occasionally swampy heath and in dry sclerophyll forest. Chiefly found in coastal areas from Bulahdelah to southern Lake Macquarie (Harden, 1992).	No heath or forest communities are present in the project area. The species is not expected to occur in the project area, as preferred habitat is not present. Therefore assessment under Section 5A of the EP&A Act is not warranted.

Table 3.1 – Likelihood of Occurrence of Threatened Flora (cont)

Species	Habitat Requirements	Likelihood of Occurrence
<i>Zannichellia palustris</i>	A submerged monoecious weakly rhizomatous aquatic annual or perennial plant. Occurs in fresh to brackish, still to slowly moving waters. Known only from the Murray River estuary and the lower Hunter region. Recent collections have been made from Ironbark Creek and tributaries at Shortland and Wallsend and in ponds on Kooragang Island. Behaves as an annual; dies back completely each summer. Individual patches of the plant range from about 5 m ² to 100 m ² , but vary from year to year.	The freshwater swamp in the project area could provide potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
White-flowered Wax Plant <i>Cynanchum elegans</i>	Stemmed climber or twiner that grows in rainforest gullies, scrub and scree slopes. <i>Cynanchum elegans</i> occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities. The species has been recorded on Kooragang Island (DLWC, 1999).	No rainforest or sclerophyll woodland habitat is present in the project area. As the project area is not considered to provide potential habitat for this species, assessment under Section 5A of the EP&A Act is not warranted.

References: Harden, 1991, 1992, 1993, 2000 and NSW NPWS Threatened Species Profiles and Final Determinations.

4.0 FAUNA OF THE PROJECT AREA

4.1 GENERAL FAUNA HABITAT

The project area offers generally poor habitat for a limited number of native fauna species. This is due to the lack of naturally-occurring remnant vegetation, a result of the “reclaimed” nature of the area; and the highly disturbed nature of the majority of the site, a result of vehicle access, mowing, and rubbish dumping.

Modified grassland covers the majority of the project area, and provides habitat for a range of bird species suited to the utilisation of degraded areas, such as the Masked Lapwing (*Vanellus miles*). The grassland provides potential foraging habitat for birds of prey such as the Barn Owl (*Tyto alba*) that was observed flying over the project area, and the Black-shouldered Kite (*Elanus axillaris*) that was observed roosting in a tree at the edge of the project area next to Cormorant Road. It also provides potential foraging habitat for microchiropteran bat species.

Native trees and shrubs have been planted in clusters along the shoreline and along Cormorant Road. These plantings offer only limited habitat to bat, bird, amphibian and reptile species due to their small size and isolated nature. No tree hollows were identified in the project area, and there is a lack of dense vegetation, leaf litter and fallen logs. Small ground-dwelling mammal habitat is therefore severely limited, and the only species likely to utilise the project area would be introduced rodents. Rubbish has been dumped between these plantings and the shoreline, which would provide artificial habitat for rodents, reptiles and amphibians.

The freshwater swamp in the project area provides potential habitat for a range of bird, small mammal, amphibian and reptile species. Fringing vegetation, emergent vegetation and aquatic vegetation are important habitat resources for these species. However, there are no open stretches of water in the swamp, and therefore no suitable foraging habitat for waders. Waders require open areas of water to ensure unobstructed views of their surrounds to keep watch for predators.

Small areas of mangrove forest and saltmarsh are located within the project area. The mangrove forest and saltmarsh areas provide foraging habitat for a range of wading birds such as the White-faced Heron (*Egretta novaehollandiae*) and White-necked Heron (*Ardea pacifica*), which forage for crustaceans in the silt trapped by the pneumatophore roots of the mangroves. The mangroves are not mature enough to provide significant hollow limbs or cavities for roosting or nesting. The fauna habitat of the mangrove forest and saltmarsh areas has been assessed from a marine fauna perspective, in the aquatic ecology assessment for this proposal authored by Ecology Lab Pty Limited.

The potential for the project area to provide important fauna habitat is limited by the areas' proximity to Cormorant Road, because of the noise and edge effects that the road creates. The disturbance created by the road, and the existence of preferable higher quality freshwater swamp, saltmarsh and mangrove habitat nearby in Kooragang Nature Reserve reduces the overall fauna habitat value of the project area and reduces the likelihood for threatened species to occur.

A fauna species list for the project area is included as **Appendix 2**. The list includes all species recorded during field investigations, as well as all species recorded within a 10 kilometre radius of the project area in the NPWS Atlas of NSW Wildlife.

4.2 BIRDS

Low species diversity was recorded within the project area during the two afternoon and evening surveys; a total of 12 bird species were recorded in or flying over the project area. The most abundant species was the Masked Lapwing (*Vanellus miles*), with eight individuals recorded in the grassland. Other species recorded included the Brown Honeyeater (*Lichmera indistincta*), Black-shouldered Kite (*Elanus axillaris*), Australian Pelican (*Pelecanus conspicillatus*) and Silver Gull (*Larus novaehollandiae*).

The Barn Owl (*Tyto alba*) was the only nocturnal bird recorded in the project area. It was observed flying over the project area twice during nocturnal surveys.

A number of bird species were recorded in or over the water in the area of the South Arm proposed for dredging. These birds included the Chestnut Teal (*Anas castanea*) and Great Cormorant (*Phalacrocorax carbo*).

No threatened or regionally significant bird species were recorded in the project area or in the area of the South Arm proposed for dredging.

A full list of the bird species recorded within a 10 kilometre radius of the project area is included in **Appendix 2**.

4.3 MAMMALS

Two mammal species were recorded within the project area during field investigations. Several threatened Grey-headed Flying Fox (*Pteropus poliocephalus*) were observed flying high over the project area. One call of the Little Forest Bat (*Vespadelus vulturinus*) was recorded flying over the mangroves in the project area. The Little Forest Bat was the most regularly recorded bat in a recent study conducted in mangrove forest on Kooragang Island (Hoye, 2002) and appears to occur in the estuary in high numbers.

A full list of the mammal species recorded within a 10 kilometre radius of the project area is included in **Appendix 2**.

4.4 HERPETOFAUNA

Area searches of the project area failed to identify any reptile species; however limited areas of potential habitat such as the clusters of native plantings, rubbish dumped near the shoreline, and driftwood on the shore of the river were identified.

Two amphibian species were recorded in the project area. The Ornate Burrowing Frog (*Limnodynastes ornatus*) and the Spotted Marsh Frog (*Limnodynastes tasmaniensis*) were both observed on grass within ten metres of the freshwater swamp.

No threatened or regionally significant reptile or amphibian species were recorded in the project area.

A full list of the reptile and amphibian species recorded within a 10 kilometre radius of the project area is included in **Appendix 2**.

4.5 THREATENED FAUNA SPECIES

One threatened species was identified in the project area; several Grey-headed Flying Fox (*Pteropus poliocephalus*) were observed flying high over the project area. This species is listed as Vulnerable on Schedule 2 of the *Threatened Species Conservation Act 1995* (NSW) and as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

4.6 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA

A number of threatened fauna species are known to occur in the vicinity of the project area. Several of these species are considered unlikely to occur in the project area, as potential habitat for these species is generally limited. A list of the threatened fauna species recorded within a 10 kilometre radius of the project area is presented in **Table 4.1** (Hoye, 2002; NPWS Atlas of NSW Wildlife). Included in the table is an indication of each species' likelihood of occurrence within the project area, and whether assessment under Section 5A of the *Environmental Planning & Assessment Act, 1979* (EP&A Act) is required.

Table 4.1 – Likelihood of Occurrence of Threatened Fauna

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Green and Golden Bell Frog <i>Litoria aurea</i>	Occurs in large permanent swamps and ponds with plenty of emergent vegetation, especially bullrushes. It will occasionally inhabit ornamental ponds and farm dams where these are close to the preferred habitat.	Has been recorded in the vicinity of artificial ponds associated with Port Waratah Coal stockpile facility to the north of the project area. The freshwater swamp in the project area provides potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Green Turtle <i>Chelonia mydas</i>	The Green Turtle is a turtle of tropical waters and is abundant along the tropical coasts of Australia and the Great Barrier Reef. The species has a pan-tropical distribution throughout the world.	The Green Turtle is only occasionally found along this part of the coast. It has been recorded twice on the NPWS Atlas in the Newcastle area. It is considered highly unlikely that the South Arm and the shore of the river would comprise potential habitat for this species. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Magpie Goose <i>Anseranas semipalmata</i>	Inhabits large seasonal wetlands and well-vegetated dams with rushes and sedges. Also wet grasslands and floodplains. The species is mostly sedentary but does disperse in the dry season.	The freshwater swamp in the project area provides potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Blue-billed Duck <i>Oxyura australis</i>	The species inhabits well-vegetated freshwater swamps, large dams and lakes. In winter the species prefers more open waters.	The freshwater swamp in the project area provides potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Freckled Duck <i>Stictonetta naevosa</i>	Inhabits large well-vegetated swamps, moving to lakes in dry periods. Breeds mostly in irregularly flooded lignum swamps in western NSW. Disperses into southeast and south coastal areas.	The freshwater swamp in the project area provides potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Providence Petrel <i>Pterodroma solandri</i>	A sea bird which breeds on Lord Howe Island. It occurs in offshore waters of Eastern Australia during April-October. It is a migratory and dispersive species.	Highly unlikely to occur in the project area, as it is an offshore bird. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Australasian Bittern <i>Botaurus poiciloptilus</i>	A partly nocturnal bird which forages over water in dense cover. Found in or over water in tall reedbeds, sedges, rushes and cumbungi. Occasionally found in saltmarsh and brackish wetlands. Nest is a shallow saucer in a platform of trampled waterplants over water in reeds.	The freshwater swamp and saltmarsh in the project area provide potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Black Bittern <i>Ixobrychus flavicollis</i>	Inhabits shadowy, leafy waterside trees such as callistemons, paperbarks, casuarinas, eucalypts, mangroves and willows. The species is also found in tidal creeks, sheltered mud flats and oyster flats. The species breeds from September to April with the nest comprising an untidy platform of sticks on a sheltered horizontal branch over water.	The mangroves in the project area may provide potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Black-necked Stork <i>Ephippiorhynchus asiaticus</i>	Found in coastal wetlands, mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore-drains, sub-artesian pools, farm dams and sewage ponds. Nest consists of a large flat pile of sticks, grass or rushes placed high and exposed in tall live and dead trees.	The mangroves and freshwater swamp in the project area provide potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Square-tailed Kite <i>Lophoictinia isura</i>	Typically inhabits the coastal forested and wooded lands of tropical and temperate Australia. Often associated with ridge and gully forests dominated by Woollybutt, Spotted Gum or Peppermint Gum. Specialist hunter of passerines and insects in the tree canopy.	No woodland is present in the project area. The species is not expected to occur in the project area, as preferred habitat is not present. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Osprey <i>Pandion haliaetus</i>	Inhabits coasts, estuaries, bays, inlets, islands and surrounding waters. May ascend large rivers (eg. Murray River). Coastal and estuarine raptor.	The project area and South Arm provide potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Great Knot <i>Calidris tenuirostris</i>	Occurs in tidal mudflats; sandy ocean and bay shores; estuaries; shallow saline and freshwater wetlands. Regular summer migrant (non breeding season – August to April) to coastal Australia.	The shoreline in the project area provides potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Broad-billed Sandpiper <i>Limicola falcinellus</i>	Migratory wader known to favour estuarine mudflats, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms and within shallow freshwater lagoons. Tends to prefer intertidal sand and mudflats in estuaries. Breeds in northern hemisphere from June to August.	The saltmarsh and shoreline in the project area provide potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Black-tailed Godwit <i>Limosa limosa</i>	A migratory wader which breeds from Mongolia to northeast Siberia. It is found inhabiting tidal mudflats, estuaries, sandspits, shallow river margins and sewage ponds. It is also found inland on large shallow fresh or brackish waters.	The shoreline of the project area provides potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Terek Sandpiper <i>Xenus cinereus</i> (= <i>Tringa terek</i>)	Regular summer migrant to coastal Australia (August to April), being fairly common from north WA to the Hunter River. Inhabits tidal mudflats; estuaries; shores and reefs of islands; coastal swamps and commercial salt fields.	The shoreline of the project area provides potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Comb-crested Jacana <i>Irediparra gallinacea</i>	This species inhabits floating vegetation of permanent, well-vegetated wetlands and dams and occasionally feeds along muddy wetland margins.	The freshwater swamp and shoreline in the project area provide potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Bush Stone-curlew <i>Burhinus grallarius</i>	Found in open woodland, dry watercourses with fallen branches, leaf litter and sparse grass; sandplains with spinifex and mallee; coastal scrub and mangrove fringes, golf courses and rail reserves; also suburbs and towns, cities in Queensland and resort islands. Lays eggs on bare ground.	No woodland is present in the project area, and the area of mangroves is small. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Sooty Oystercatcher <i>Haematopus fuliginosus</i>	Intertidal rocky and coral reefs, mostly on ocean shores. Breeds mostly on offshore islands. It occasionally frequents sandspits and tidal mudflats, mostly when not breeding.	The shoreline of the project area provides potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Pied Oystercatcher <i>Haematopus longirostris</i>	Habitats include undisturbed sandy, shellgrit or pebbly beaches; sandspits and sandbars; tidal mudflats and estuaries, and coastal islands. The species breeds between August and January.	The shoreline of the project area provides potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Greater Sand Plover <i>Charadrius leschenaultii</i>	Inhabits wide sandy or shelly beaches; sandspits, tidal mudflats, reefs, sand-cays, mangroves, saltmarsh, dune wilderness, bare paddocks; seldom occurs far inland. Regular summer (August-May) migrant to Australia, breeds from Turkey to southern Siberia.	The mangroves, saltmarsh and shoreline of the project area provide potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Lesser Sand (Mongolian) Plover <i>Charadrius mongolus</i>	A migratory wader which breeds in Siberia. Occurs on tidal mudflats and sandflats, gently sloping sandy and shelly beaches, saltmarsh, estuaries, atolls, reefs, mangroves and airfields.	The mangroves, saltmarsh and shoreline of the project area provide potential foraging habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Little Tern <i>Sterna albifrons</i>	Occurs in coastal waters, bays, inlets, saline or brackish lakes, saltfields and sewage ponds near the coast. It breeds in colonies on islands, sandspits, beaches and dune wastes. It nests in scrapes in sand or shell debris between the high tide mark and shore vegetation.	The shoreline of the project area provides potential habitat for this species. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Wompoo Fruit-Dove <i>Ptilinopus magnificus</i>	The Wompoo Fruit-dove inhabits rainforests, monsoon forests, adjacent Eucalypt forests or fruiting trees on scrubby creeks or in open country. The Lower Hunter represents the southern-most extent of its range.	No forest or fruiting trees are present in the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Rose-crowned Fruit-Dove <i>Ptilinopus regina</i>	The Rose-crowned Fruit-dove is associated with rainforests, vine scrubs, adjacent Eucalypt forests and woodlands, swamp woodlands, mangroves, berry or fruit-bearing trees in public and private gardens. The Hunter River is the accepted southern extremity for the species. The species breeds from November to April.	No forest, woodland or fruiting trees are present in the project area. The area of mangroves is small. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Superb Fruit-Dove <i>Ptilinopus superbus</i>	Inhabits rainforests and fringes; scrubs, mangroves, wooded stream-margins, lantana thickets, isolated figs, pittosporums, lilly pillys and blackberries. The species generally breeds for September to January.	No rainforest occurs in the project area, and only a limited amount of mangroves exists. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Swift Parrot <i>Lathamus discolor</i>	Feeds on blossom-nectar, lerp-insects in foliage, soft fruits, berries, and sometimes forages in grass. Preferred habitat is forests, woodlands, plantations, banksias, street trees, parks and gardens. Breeds only in Tasmania, most migrate to SE Aust in March-June.	Limited trees are available in the project area, and vegetation is highly disturbed. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Turquoise Parrot <i>Neophema pulchella</i>	Prefers open grassy woodland habitat, with dead trees, near permanent water and forested hills. Habitats also include coastal heath, pastures with exotic grasses, weeds, roadside and orchards. Feeds on seeds of grasses, herbaceous plants and shrubs and requires a reliable supply of drinking water. Nests in the dead stump or spout of an Eucalypt and breeds between August to December and April to May.	No woodland or dead trees are available in the project area, and vegetation is highly disturbed. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Barking Owl <i>Ninox connivens</i>	Ideal habitat is open country with a choice of large trees for roosting and nesting. The owl has a distinct preference to be close to water and is often found associated with River Red gums.	Large trees are absent from the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Powerful Owl <i>Ninox strenua</i>	Occupies an extensive home range of up to 1000 hectares, generally within 200 kilometres of the coast in southeastern Australia. Habitat preferences include mountain forests; gullies and forest margins; sparser hilly woodlands; coastal forests, woodlands, scrubs; exotic pine plantations; and large trees in private/public gardens. The species breeds between June and September, nesting in a hollow trunk or limb 8 metres to 20 metres or more high in a tree.	No woodland, forest, or large trees are available in the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Regent Honeyeater <i>Xanthomyza phrygia</i>	Inhabits temperate Eucalypt woodlands and open forests including forest edges. Associations of Red Ironbark, White Box, Yellow Box, Yellow Gum and Red Box appear essential. Swamp Mahogany and River Oak may be used locally.	No woodland or forest is available in the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Brush-tailed Phascogale <i>Phascogale tapoatafa</i>	Feeds mainly on cockroaches, beetles, centipedes, spiders and even bull ants, but is an occasional predator of small vertebrates. Nectar forms part of its diet. Prefers to forage in large trees, especially on dead branches. Nest sites include hollow tree limbs, rotted stumps and globular bird nests. Prefers open forest with sparse ground cover.	No woodland, forest, or large trees are available in the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Koala <i>Phascolarctos cinereus</i>	Habitat consists of Eucalypt forest and woodlands containing particular species including Red Gum, Grey Gum, Manna Gum, Tallowwood, and Swamp Mahogany.	No woodlands or forests are available in the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Squirrel Glider <i>Petaurus norfolcensis</i>	Occurs in wet and dry sclerophyll forests and woodlands, nests in tree hollows and feeds on insects, acacia gum and eucalypt sap released by incising the bark. The species has a home range of 20 to 30 hectares.	No woodland or forest or tree hollows are available in the project area. The species is not expected to occur in the project area, as preferred habitat is absent. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Grey-headed Flying-fox <i>Pteropus poliocephalus</i>	Roost sites (camps) are commonly formed in gullies, typically not far from water and usually in vegetation with a dense canopy cover. Feeds on a wide variety of flowering and fruiting plants, including blossoms of eucalypts, banksias, figs and palms.	The species was recorded flying high over the project area and potential foraging habitat exists in Date Palms in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Yellow-bellied Sheath-tail Bat <i>Saccolaimus flaviventris</i>	Found in rainforests, sclerophyll forests and woodlands, this species roosts alone or with up to 10 others in large hollow trees, the abandoned nests of Sugar Gliders or in buildings. It hunts high above the forest canopy and in clearings. Migratory in southern Australia.	Recorded in dry forest habitat at Fern Bay (Clements & Associates, 1992). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Eastern Freetail Bat <i>Mormopterus norfolkensis</i>	Habitat preferences are unclear, with most records from dry eucalypt forest and woodland east of the Great Dividing Range. Has also been recorded flying low over a rocky river through rainforest and wet sclerophyll forest. Predominantly tree roosting; however, it has been recorded roosting in a roof with other bat species.	Recorded in mangrove habitat on Kooragang Island (Hoye, 2002) and on Ash Island (Hoye, unpub.). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	Typically roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Found in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. It probably forages for small insects below the forest canopy.	Recorded in mangrove habitat on Kooragang Island (Hoye, 2002). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Little Bent-wing Bat <i>Miniopterus australis</i>	Forages for insects beneath the canopy of well-timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. It roosts in caves and tunnels, often sharing roosting sites with the Common Bent-wing Bat.	Recorded in mangrove habitat on Kooragang Island (Hoye, 2002). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Common Bent-wing Bat <i>Miniopterus schreibersii</i>	Occurs in wet and dry sclerophyll forests and rainforests. This species generally hunts above the forest canopy, and roosts in caves, mine tunnels and buildings.	Recorded in mangrove habitat on Kooragang Island (Hoye, 2002). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Large-footed Myotis <i>Myotis adversus</i>	The species is typically cave roosting, however it may also roost in buildings and in dense foliage. It typically forages over waterbodies and along streams, catching aquatic and flying insects.	Recorded in mangrove habitat on Kooragang Island (Hoye, 2002). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i>	Tree hollow roosting species which inhabits the gullies and river systems draining the Great Dividing Range, extending to the coast over much of its range. Habitats range from woodland through to moist and dry eucalypt forest to rainforest. Flies slowly between the canopy and understorey of forests, in paddocks and above water. Known to prey on beetles and other large, slow-flying insects. Evidence suggests that it also preys on other bat species.	Recorded in mangrove habitat on Kooragang Island (Hoye, 2002) and in dry forest habitat at Fern Bay (Clements & Associates, 1992). Potential foraging habitat exists in the project area. An assessment of the potential impact of the proposal on this species is provided in Appendix 3 .

Table 4.1 – Likelihood of Occurrence of Threatened Fauna (cont)

Species	Ecology and Habitat Requirements	Likelihood of Occurrence
New Zealand Fur-seal <i>Arctocephalus forsteri</i>	Preys on fish and cephalopods, and to a lesser extent on birds such as penguins, both in shallow inshore waters and around the margins of the continental shelf. The species utilises rocky habitat as breeding and haul-out sites and appears to avoid open rock platforms and sandy or pebbly beaches. Although the species does not breed in NSW, habitat and resources within the state remain important to non-breeding individuals.	This species is uncommon along this part of the NSW coast. It has been recorded twice on the NPWS Atlas in the Newcastle area. It is considered highly unlikely that the South Arm or the shore of the river would comprise potential habitat for this species. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Dugong <i>Dugong dugon</i>	The Dugong's main food is seagrass, and to a much lesser extent marine algae when seagrass is scarce. The Dugong has a broad but disjunct distribution in tropical and subtropical shallow coastal waters of the Indian and Western Pacific Oceans. In NSW, visiting Dugongs have been recorded as far south as Twofold Bay, although the majority of records are for waters north of Jervis Bay. The Dugong does not breed in NSW, however habitat and resources within the state remain important to visiting individuals.	The lack of significant seagrass beds makes it highly unlikely that the Dugong would occur in the South Arm. It is considered highly unlikely that the South Arm would comprise potential habitat for this species. Therefore assessment under Section 5A of the EP&A Act is not warranted.
Humpback Whale <i>Megaptera novaeangliae</i>	Migrates in winter from feeding grounds in the polar seas to sub-tropical and tropical breeding areas off the east and west coasts of Australia.	The Humpback Whale is extremely unlikely to enter the South Arm due to the lack of feeding resources and the shallow depth. It is considered highly unlikely that the South Arm would comprise potential habitat for this species. Therefore assessment under Section 5A of the EP&A Act is not warranted.

References: Mammals – Cronin (1991), Menkhorst & Knight (2001), Strahan (1998); Frogs – Robinson (1995); Birds – Pizzey & Knight (1997), Hollands (1991).

5.0 IMPACTS OF THE PROPOSAL

5.1 PROPOSED SITE DISTURBANCE

Excavation for the proposed swing basin will impact on land above the high water mark on both banks of the South Arm. The swing basin will be located approximately 200 metres east of the Tourle Street Bridge, and construction will involve removal of a portion of the OneSteel site on the south bank, and removal of an area of mangrove forest on the north bank. The remainder of the land on the north bank between the Tourle Street Bridge to just south of the intersection of Cormorant Road and Egret Street may be disturbed for works associated with the dredging.

The BHP closure area, located on the southern shore of the South Arm, is proposed for dredge spoil handling and containment activities. Contaminated soft silty clays will be dewatered en route to and within a holding facility on this site. Remediation of these contaminated sediments will be conducted on site.

5.2 IMPACT ON FLORA

The proposal involves the removal or alteration of all vegetation in the project area, on the north bank of the South Arm between the Tourle Street Bridge to just south of the intersection of Cormorant Road and Egret Street. Vegetation communities identified in this area were: 13.7 hectares of Modified Grassland; 7.6 hectares of Plantings of Native Species; 8.6 hectares of Mangrove Forest; 1.3 hectares of Saltmarsh Vegetation; and 2.2 hectares of Freshwater Swamp Vegetation.

The 8.6 hectares of Mangrove Forest in the project area is equivalent to 0.50% of the area of mangrove in the lower Hunter River, and 1.36% of the area of mangrove on Kooragang Island, as mapped in 1994 (Williams *et al.*, 2000). The 1.3 hectares of Saltmarsh Vegetation in the project area is equivalent to 0.19% of the area of saltmarsh in the lower Hunter River, and 0.30% of the area of saltmarsh on Kooragang Island, as mapped in 1994 (Williams *et al.*, 2000). Therefore, the removal of these communities in the project area would not constitute a significant loss in terms of the amount of similar habitat in close proximity.

The vegetation communities in the project area are not remnant, and are all highly disturbed by factors including: rubbish dumping; vehicular access; and mowing. The removal of this vegetation is not considered to be significant from a local or regional perspective, due to the small size of the area, the prior disturbance of the vegetation, and the proximity of larger areas of protected mangrove and saltmarsh vegetation in the Kooragang Nature Reserve.

The removal of mangroves under the proposal will require a permit from NSW Fisheries in accordance with S205 of the *Fisheries Management Act 1994*.

Indirect potential impacts of the proposal on mangroves and other vegetation in the local area could include:

- Changes in water flow or water quality as a result of dredging, and erosion of mud or sand on river banks as a result of altered water flows. However, little change in tidal or flood flows is expected as a result of dredging (Patterson Britton & Partners Pty Ltd 2003). Also, a net improvement in surface water quality in the South Arm is expected, through the removal of contaminated sediments during the proposed dredging operations.
- Erosion of mud or sand on river banks as a result of bow waves of large vessels.

- The smothering of mangrove pneumatophores by sediment disturbed by dredging, leading to stress or death of mangroves. Deposition of sediment in sensitive areas such as mangroves south of Ironbark Creek is considered to be around the magnitude at which concerns may be raised (Patterson Britton & Partners Pty Ltd 2003). Patterson Britton & Partners Pty Ltd (2003) recommended that water quality (particularly turbidity), sediment deposition rates, and the mangrove colonies in the South Arm, particularly south of Ironbark Creek, should be monitored during the dredging operations to prompt mitigation measures if required. The mitigation measures would take the form of a floating turbidity barrier(s) installed across the river upstream of the dredge area.

GHD advise that groundwater changes are expected to be minimal. It is predicted that there will be no alterations to groundwater flow direction as a result of the proposed swing basin excavations. It is considered likely that the proposed dredging would reduce the length of time discharging groundwater takes to reach the surface water of the South Arm, particularly in the vicinity of the proposed swing basin. The discharging groundwater from the OneSteel site contains elevated concentrations of some contaminants, however because no change in flow direction is predicted, and groundwater is already leaving the site, no further environmental impact is related to the proposed development. With respect to the contamination potential of the proposed development from the temporary storage of excavation and dredging wastes on land, no significant alteration in groundwater quality is expected.

Given that there would be little alteration to the flooding regime, and also tidal hydrodynamics, the frequency and duration of inundation for wetland and swamp areas would not be expected to be altered significantly. Therefore, it would not be expected that there would be significant alterations to groundwater characteristics in these wetland and swamp areas, such as the Kooragang Island wetlands and Hexham Swamp (Patterson Britton & Partners Pty Ltd 2003).

Salinity intrusion is predicted to slightly reduce as a result of the proposed dredging, *although not to the extent of significantly impacting on mangroves, saltmarsh and fish* (Patterson Britton & Partners Pty Ltd 2003).

The OneSteel site on the south bank of the South Arm is a highly disturbed industrial site with no significant vegetation.

The BHP closure area is also a highly disturbed industrial site with no significant vegetation.

5.3 IMPACT ON FAUNA HABITAT

The proposal involves the removal or alteration of all fauna habitat in the project area, on the north bank of the South Arm between the Tourle Street Bridge to just south of the intersection of Cormorant Road and Egret Street. Relatively low fauna species diversity was recorded in the project area during field investigations. The fauna habitat available is highly disturbed by rubbish dumping, vehicular access, mowing, and the noise of Cormorant Road. Therefore only a limited number of native fauna species are likely to utilise the project area as primary habitat.

Habitat for waders is limited in the project area, restricted to small areas of sandy shoreline, mangrove forest, saltmarsh and modified pasture. No important feeding or roosting habitat was identified in the project area. Waders prefer intertidal mudflats and sandflats, and isolated roosting areas, all of which are absent from the project area.

Therefore the removal of fauna habitat in the project area is considered not to be significant from a local or regional perspective. Substantially larger areas of less disturbed habitat occur nearby in the Kooragang Nature Reserve and in surrounding areas.

Indirect potential impacts of the proposal on fauna habitat in the local area could include:

- noise associated with dredging, excavation works, sheet piling, onshore materials handling and remediation activities.

No groundwater impacts are expected on habitat in Kooragang Wetlands, Hexham Swamp and other areas of important habitat as a result of the proposed dredging. Minimal groundwater impacts are predicted in the immediate vicinity of the dredging and excavation site (refer to **Section 5.2**).

Minimal change in tidal or flood flows is expected as a result of dredging (Patterson Britton & Partners Pty Ltd 2003). Therefore the proposal is not expected to impact upon the feasibility of the plan to open estuary floodgates to allow for the inundation of Hexham Swamp. Similarly, minimal changes in the hydrology of the south and the north arm of the Hunter River are expected as a result of dredging (Patterson Britton & Partners Pty Ltd 2003). Important habitat areas such as Fullerton Cove, northwest Kooragang Island and Tomago Wetlands would not be adversely impacted by the proposed dredging.

Salinity intrusion is predicted to slightly reduce as a result of the proposed dredging, although not to the extent of significantly impacting on mangroves, saltmarsh and fish (Patterson Britton & Partners Pty Ltd 2003).

Patterson Britton & Partners Pty Ltd (2003) predicted that during dredging operations, elevated suspended sediment concentrations may potential harm aquatic life such as fish, although the Hunter estuary is noted as already having high suspended sediment concentrations. Turbidity curtains would be used in conjunction with various dredging operations to minimise the dispersion of suspended sediment. Dispersion of pollutants in the sediments suspended as part of the dredging operations is not considered to be a significant issue (Patterson Britton & Partners Pty Ltd 2003).

The OneSteel site on the south bank of the South Arm is a highly disturbed industrial site with no significant fauna habitat.

The BHP closure area is also a highly disturbed industrial site with no significant fauna habitat.

5.4 IMPACT ON THREATENED SPECIES

5.4.1 Commonwealth Legislation

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on matters of national environmental significance. These matters are:

- World Heritage properties;
- Ramsar wetlands;
- cetaceans, migratory species, threatened species, critical habitats or ecological communities listed in the EPBC Act;

- Commonwealth land, marine areas or reserves; and
- nuclear actions.

No threatened species of flora were identified in the project area. Several Grey-headed Flying Foxes (*Pteropus poliocephalus*), listed as Vulnerable under the EPBC Act, were observed flying high over the project area. Four bird species listed as migratory under the EPBC Act were observed in the project area: the Chestnut Teal (*Anas castanea*); Great Egret (*Ardea alba*); Black-shouldered Kite (*Elanus axillaris*); and Masked Lapwing (*Vanellus miles*).

Potential habitat for the Vulnerable Green and Golden Bell Frog (*Litoria aurea*) was identified in the freshwater swamp in the project area. However, the species was not observed despite targeted surveys undertaken in optimum conditions after two days of rain in December. Therefore it was concluded that the species is unlikely to be present in the project area.

Habitat available in the project area is of a highly disturbed nature, and larger areas of similar habitat of a higher quality are present in the local area. Under the proposal, all terrestrial flora and fauna habitat in the project area would be either lost completely, or highly modified. However, this habitat is not considered to be "important habitat" (as defined under the EPBC legislation) for any migratory bird species that was observed in the project area, because:

- the habitat is not utilised by a migratory species within a region that supports an ecologically significant proportion of the population of the species;
- the habitat is not utilised by a migratory species which is at the limit of the species' range; and
- the habitat is not within an area where the species is declining.

The Grey-headed Flying Foxes observed flying over the project area were not utilising any habitat within the area. Potential foraging habitat for the species is restricted to a few Date Palms in the project area, which are unlikely to comprise a significant resource for this highly mobile species.

Therefore it is considered highly unlikely that the loss of habitat in the project area would have a significant impact on any threatened or migratory species occurring in the area.

While many of the migratory bird species listed under the EPBC Act may occur in the project area, it is considered that the project area is unlikely to provide an area of "important habitat" for any of these species. Habitat available in the project area is highly disturbed, and restricted to small areas of sandy shoreline, mangrove forest, saltmarsh and modified pasture. Larger and less disturbed areas of similar habitat are commonly available on Kooragang Island and in surrounding areas. The nearby North Arm of the Hunter River and Fullerton Cove provide significant feeding and roosting habitat for many migratory bird species, and much of this habitat is protected within the Kooragang Nature Reserve. The habitat utilised in these areas consists of extensive intertidal mudflats and sandflats, and isolated roosting areas, which are much more suited to the requirements of wading species than the limited resources of the project area. Therefore it is considered that habitat removal under the proposal is unlikely to have a significant impact on any migratory species potentially occurring within the project area.

A list of migratory species (as defined in the EPBC Act) recorded within 10 kilometres of project area in the NPWS Atlas of NSW Wildlife, is provided in **Appendix 4**.

5.4.2 State Legislation

5.4.2.1 Threatened Species Conservation Act, 1995

Threatened Species

The *Threatened Species Conservation Act 1995* (TSC Act) lists threatened species, populations and ecological communities in New South Wales, along with key threatening processes. The status of threatened species, populations and ecological communities are determined by the Scientific Committee as either Endangered (Schedule 1) or Vulnerable (Schedule 2).

No currently listed endangered populations, endangered ecological communities, or areas of critical habitat were recorded in the project area.

No threatened flora species were identified in the project area.

One threatened fauna species was identified in the project area; several Grey-headed Flying Fox (*Pteropus poliocephalus*) were observed flying high over the project area. This species is listed as Vulnerable on Schedule 2 of the TSC Act.

Eight part tests are required under Section 5A of the *Environmental Planning & Assessment Act 1979* to assess impacts of the proposed development on those species listed under the TSC Act. Eight part tests have been undertaken for the threatened species that was recorded in the project area, and those species for which potential habitat is considered to be present (refer to **Tables 3.1** and **4.1**). Eight part tests are included as **Appendix 3**.

It was found on the basis of the eight part tests that it is unlikely that the proposal would have a significant impact on any species, population or ecological community currently listed under the TSC Act. Therefore a species impact statement is not required for the proposal.

Key Threatening Processes

The “Loss of biodiversity as a result of loss and/or degradation of habitat following clearing and fragmentation of native vegetation” or the “Clearing of native vegetation” is recognised as a major factor contributing to loss of biological diversity (NPWS, 2001). In New South Wales since 1788 at least 61% of the original native vegetation has been cleared, thinned or substantially or significantly disturbed (Environment Protection Authority, 1997).

Some examples of the impacts of the clearing of native vegetation on biological diversity are:

- destruction of habitat results in loss of local populations of individual species;
- fragmentation of habitat;
- expansion of dryland salinity;
- riparian zone degradation;
- increased greenhouse gas emissions;

- increased habitat for invasive species;
- loss of leaf litter layer;
- loss or disruption of ecological function; and
- changes to soil biota (NPWS, 2001).

The removal of native vegetation in the project area is not considered to constitute a key threatening process, as it would not result in a significant loss of biodiversity. The vegetation communities are small in size and are represented in larger areas in the local area and region.

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a major factor contributing to loss of biological diversity and ecological function in aquatic ecosystems, including floodplains (NPWS, 2002). In New South Wales since 1788 most of the original aquatic ecosystems have had major modification of their flow regime through river regulation by damming, or altered flows in channels or on floodplains through draining, extraction and diversion of water. Alteration of natural flow regimes in rivers and streams and their floodplains and wetlands has a variety of impacts which include:

- reduction of habitat due to change in area, frequency and duration of flooding of floodplains and terminal wetlands;
- increased flows causing more permanent flooding of some wetlands;
- riparian zone degradation through altered flow patterns;
- increased habitat for invasive species; and
- loss or disruption of ecological function (NPWS, 2002).

Disruption of ecological processes may continue long after initial flow alteration, causing continued decline in biological diversity (NPWS, 2002).

The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary. Simulations undertaken by Patterson Britton & Partners Pty Ltd (2003) have shown that dredging could cause a maximum change in water level at the Tourle Street Bridge of -0.127 metres. Maximum water level changes in other locations in the South and North Arm such as Ironbark Creek and Fullerton Cove were found to be smaller, in the order of -0.050 metres and -0.006 metres respectively. Overall, the modelling results indicate that tidal hydrodynamics would remain virtually unchanged after the proposed dredging. Slightly more tidal flow would pass through the South Arm, with a slightly increased tidal range at locations near the dredged area. However, the magnitudes of these changes would be very small and would not be expected to have any measurable impacts (Patterson Britton & Partners Pty Ltd 2003).

With regard to flooding, it was found that the general flood flow distribution, volumes and duration would not be altered by a significant amount. It was estimated that there would be a localised and substantial reduction in peak flood levels in the South Arm in the vicinity of Tourle Street Bridge (0.6 metres in the 1% AEP event), and a slightly reduced flood risk throughout the lower Hunter estuary. These benefits were not expected to cause significant

impacts on ecosystems relying on flood inundation (Patterson Britton & Partners Pty Ltd 2003).

Salinity intrusion was predicted to slightly reduce, although not to the extent of significantly impacting on mangroves, saltmarsh and fish (Patterson Britton & Partners Pty Ltd 2003).

A range of mitigation measures will be implemented to ensure that any impact on the surrounding environment is minimised (refer to **Section 6.2**).

5.4.2.2 SEPP 44 Assessment

The proposed dredging of the South Arm is subject to assessment under State Environmental Planning Policy (SEPP) No. 44 (Koala Habitat Protection) as it lies in a local government area listed in Schedule 1 of the policy. SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for the Koala, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline. Any development application in an identified local government area, affecting an area one hectare or greater, must be assessed under the policy.

Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential Koala habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 of the policy constitute 15% or more of the total number of trees in the upper or lower strata of the tree component. If potential Koala habitat is present, the area must be further assessed to determine if the land is core Koala habitat.

The species listed in Schedule 2 of the policy are:

Scientific Name	Common Name
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus punctata</i>	Grey Gum
<i>Eucalyptus viminalis</i>	Ribbon or Manna Gum
<i>Eucalyptus camaldulensis</i>	River Red Gum
<i>Eucalyptus haemastoma</i>	Broad Leaved Scribbly Gum
<i>Eucalyptus signata</i>	Scribbly Gum
<i>Eucalyptus albens</i>	White Box
<i>Eucalyptus populnea</i>	Bimble Box or Poplar Box
<i>Eucalyptus robusta</i>	Swamp Mahogany

The River Red Gum (*Eucalyptus camaldulensis*) is present in low numbers in the project area. The species has been introduced to the area for aesthetic purposes, planted with other Australian native species in isolated clumps. Therefore the River Red Gums are isolated from one another by mowed modified grassland, and do not form a potential Koala pathway. The species constitutes less than 15% of canopy species in the project area, therefore the project area does not provide potential Koala habitat and no further assessment is required.

6.0 MANAGEMENT REQUIREMENTS

6.1 MANAGEMENT PROCEDURES

Dredging operations should be managed to minimise potential impacts on surrounding vegetation (especially mangroves upstream of the dredging area) caused by sediment resuspension and transport. Silt curtains should be implemented to reduce the amount of sediment leaving the dredge site.

The maintenance/ establishment of vegetation on the foreshore of the South Arm where feasible would assist in minimising erosion of the bank and thereby avoid the introduction of additional sediment into the river.

Landscape planting should be established as soon as practicable on available areas of land on the north bank of the South Arm. These plantings should comprise locally indigenous species, so as to provide a small amount of habitat to local fauna.

Appropriate measures need to be taken to prevent sediment and contaminated leachate entering the South Arm during spoil handling and containment activities.

6.2 MONITORING AND MAINTENANCE

Mangrove forest and associated fauna should be monitored upstream of the dredge site during dredging operations, to prompt mitigation measures if required, and to ensure that the project does not result in the loss of mangrove habitat upstream.

6.3 COMPENSATORY HABITAT

The Compensatory Wetland Policy under SEPP 14 – Coastal Wetlands has been discussed here as a guide to appropriate compensation, although the project area does not contain SEPP 14 wetland.

The concept of wetland compensation aims to achieve no net loss of coastal wetlands in NSW and if possible to help reverse the historical trend in wetland decline (SEPP 14 – Coastal Wetlands, Compensatory Wetlands Policy). Compensation should aim to offset the natural values and functions of the wetland being damaged or destroyed. The principle of “like for like” should be prominent in the selection of compensation areas in terms of wetland type and species composition. For compensation purposes, restoration of previously degraded wetlands is preferable to creation of artificial wetlands. The area selected to be restored (or artificial compensatory wetland) should be as close to the wetland to be disturbed as possible, and preferably within the same catchment. A compensatory wetland should be undertaken at the ratio of 10:1 to the wetland area destroyed and/or permanently impacted. A restoration project should be monitored by the Developer for at least 10 years to ensure the system is stable. Reports on the progress of the wetland compensation project should be submitted to PlanningNSW or the relevant council annually.

The proposal involves the removal of 8.6 hectares of Mangrove Forest and 1.3 hectares of Saltmarsh Vegetation on the north bank of the South Arm. It is recommended that habitat compensation should be undertaken for the loss of both of these communities, and not be limited to mangrove replacement. Habitat compensation could involve the restoration of existing areas of damaged vegetation in the local area, or the establishment of new areas of mangrove and saltmarsh vegetation in the local area. It is recommended that augmentation of an area of existing habitat would be more valuable than the creation of an isolated area of

habitat. Similarly, it is considered that habitat enhancement would be of more value than habitat creation.

Although this project will not directly impact areas of significant wader habitat, the creation and maintenance of intertidal feeding areas and roosting habitat for waders in the local area are recommended as valuable contributions to the ecology of the lower Hunter estuary.

Another alternative is the provision of financial contributions to wetland rehabilitation projects in the local area, such as the Hexham Swamp Rehabilitation Project coordinated by the Hunter Catchment Trust, the Kooragang Wetland Rehabilitation Project, or The Wetlands Centre Australia at Shortland.

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APPENDIX 1

Flora Species List

Flora Species List

The following is a list of the flora species recorded in the project area.

Introduced – Refers to exotic or Australian native species that have been introduced to the project area and do not naturally occur in the area.

No threatened flora species were identified in the project area.

Nomenclature is consistent with Harden (1991, 1992, 1993, 2000).

Family/Genus	Species	Common Name	Status
AIZOACEAE <i>Arpobrotus</i>	<i>glaucescens</i>	Coastal Pigface	
APIACEAE <i>Foeniculum</i> <i>Hydrocotyle</i> <i>Phoenix</i>	<i>vulgare</i> <i>bonariensis</i> <i>dactylifera</i>	Fennel American Pennywort Date Palm	Introduced Introduced Introduced
ASCLEPIADACEAE <i>Gomphocarpus</i>	<i>fruticosus</i>	Narrow-leaf Cotton Bush	Introduced
ASPARAGACEAE <i>Protasparagus</i>	<i>aethiopicus</i>	Asparagus Fern	Introduced
ASTERACEAE <i>Bidens</i> <i>Cassinia</i> <i>Cirsium</i> <i>Conyza</i> <i>Chrysanthemoides</i> <i>Hardenbergia</i> <i>Hypochoeris</i> <i>Senecio</i> <i>Sonchus</i> <i>Taraxacum</i>	<i>pilosa</i> sp. <i>vulgare</i> <i>bonariensis</i> <i>monilifera</i> ssp. <i>rotundata</i> <i>violacea</i> <i>radicata</i> <i>madagascariensis</i> <i>oleraceus</i> <i>officinale</i>	Cobbler's Pegs Spear Thistle Fleabane Bitou Bush False Sarsaparilla Catsear Fireweed Common Sowthistle Dandelion	Introduced Introduced Introduced Introduced Introduced Introduced Introduced Introduced Introduced
AVICENNIACEAE <i>Avicennia</i>	<i>marina</i> subsp. <i>australasica</i>	Grey Mangrove	
CARYOPHYLLACEAE <i>Petrorrhagia</i>	<i>nanteuillii</i>	Proliferous Pink	Introduced

Family/Genus	Species	Common Name	Status
CASUARINACEAE <i>Casuarina</i> <i>Casuarina</i>	<i>equestifolia</i> subsp. <i>incana</i> <i>glauca</i>	Coastal She-Oak Swamp She-Oak	Introduced
CHENOPODIACEAE <i>Sarcocornia</i> <i>Suaeda</i>	<i>quinqueflora</i> <i>australis</i>	Samphire Austral Seablight	
CYPERACEAE <i>Isolepis</i>	<i>nodosus</i>		
FABACEAE <i>Glycine</i> <i>Medicago</i> <i>Trifolium</i>	sp. sp. sp.	Medic Clover	Introduced Introduced
GERANIACEAE <i>Geranium</i>	sp.		
JUNCACEAE <i>Juncus</i> <i>Juncus</i> <i>Juncus</i>	<i>acutus</i> <i>kraussii</i> <i>usitatus</i>	Spiny Rush Sea Rush Common Rush	Introduced
LAMIACEAE <i>Westringia</i>	<i>fruticosa</i>	Coastal Rosemary	
LOMANDRACEAE <i>Lomandra</i>	<i>longifolia</i>	Spiny-headed Mat-rush	
MIMOSACEAE <i>Acacia</i> <i>Acacia</i>	<i>longifolia</i> subsp. <i>sophorae</i> <i>saligna</i>	Coastal Wattle Willow Wattle	
MYRSINACEAE <i>Aegiceras</i>	<i>corniculatum</i>	River Mangrove	
MYRTACEAE <i>Eucalyptus</i> <i>Leptospermum</i> <i>Leptospermum</i> <i>Melaleuca</i> <i>Melaleuca</i>	<i>camaldulensis</i> <i>laevigatum</i> <i>polygalifolium</i> <i>armillaris</i> <i>nesophila</i>	River Red Gum Coastal Tea-tree Lemon-scented Tea-tree Lace Myrtle	Introduced

Family/Genus	Species	Common Name	Status
ONAGRACEAE <i>Oenothera</i>	<i>drummondii</i>	Beach Primrose	
OXALIDACEAE <i>Oxalis</i>	sp.	Oxalis	
PLANTAGINACEAE <i>Plantago</i>	<i>lanceolata</i>	Plantain	Introduced
POACEAE <i>Aristida</i> <i>Austrodanthonia</i> <i>Avena</i> <i>Briza</i> <i>Chloris</i> <i>Cynodon</i> <i>Elymus</i> <i>Eragrostis</i> <i>Panicum</i> <i>Paspalum</i> <i>Phalaris</i> <i>Poa</i> <i>Pennisetum</i> <i>Phragmites</i> <i>Sporobolus</i> <i>Themeda</i>	sp. <i>caespitosa</i> sp. <i>minor</i> <i>gayana</i> <i>dactylon</i> <i>scaber</i> sp. sp. <i>dilatatum</i> <i>aquatica</i> sp. <i>clandestinum</i> <i>australis</i> <i>virginicus</i> <i>australis</i>	Wire Grass Wallaby Grass Oat Shivery Grass Rhodes Grass Couch Common Wheat Grass Lovegrass Panic Paspalum Phalaris Kikuyu Common Reed Sand Couch Kangaroo Grass	Introduced Introduced Introduced Introduced Introduced Introduced Introduced Introduced
PRIMULACEAE <i>Anagallis</i>	<i>arvensis</i>	Pimpernel	Introduced
PROTEACEAE <i>Banksia</i>	<i>integrifolia</i>	Coastal Banksia	

APPENDIX 2

Fauna Species List

Fauna Species List

This fauna list has been compiled from NPWS Atlas of NSW Wildlife records and other studies of the local area. The species listed have been recorded within a 10 kilometre radius of the project area in the NPWS Atlas of NSW Wildlife, except for those species in bold type, which have been identified in local studies. The Umwelt Study column records those species identified in the project area during the fauna surveys conducted in November and December 2002.

- X = Species recorded by Umwelt in the project area
 E1 = Endangered under Schedule 1 of the *Threatened Species Conservation Act, 1995*
 V = Vulnerable under Schedule 2 of the *Threatened Species Conservation Act, 1995*
 P = Protected under the *National Parks and Wildlife Act, 1979*
 U = Unprotected

Scientific Name	Common Name	Status	Umwelt Study
AMPHIBIANS			
<i>Adelotus brevis</i>	Tusked Frog	P	
<i>Crinia signifera</i>	Common Eastern Froglet	P	
<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	P	X
<i>Limnodynastes peronii</i>	Striped Marsh Frog	P	
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog	P	X
<i>Pseudophryne coriacea</i>	Red-backed Toadlet	P	
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1	
<i>Litoria caerulea</i>	Green Tree Frog	P	
<i>Litoria dentata</i>	Keferstein's Tree Frog	P	
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	P	
<i>Litoria latopalmata</i>	Broad-palmed Frog	P	
<i>Litoria lesueuri</i>	Lesueur's Frog	P	
<i>Litoria peronii</i>	Peron's Tree Frog	P	
<i>Litoria phyllochroa</i>	Green Stream Frog	P	
<i>Litoria tyleri</i>	Tyler's Tree Frog	P	
<i>Litoria verreauxii</i>	Verreaux's Tree Frog	P	
REPTILES			
<i>Chelonia mydas</i>	Green Turtle	V	
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle	P	
<i>Pygopus lepidopus</i>	Southern Scaly-foot	P	
<i>Amphibolurus muricatus</i>	Jacky Lashtail	P	
<i>Pogona barbata</i>	Eastern Bearded Dragon	P	
<i>Varanus varius</i>	Lace Monitor	P	
<i>Ctenotus robustus</i>	Robust Ctenotus	P	
<i>Cyclodomorphus michaeli</i>		P	
<i>Egernia major</i>	Land Mullet	P	
<i>Eulamprus quoyii</i>	Eastern Water-skink	P	
<i>Eulamprus tenuis</i>	Bar-sided Forest-skink	P	
<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink	P	
<i>Lampropholis guichenoti</i>	Pale-flecked Garden Sunskink	P	

Scientific Name	Common Name	Status	Umwelt Study
<i>Lampropholis</i> sp.	unidentified grass skink	P	
<i>Saiphos equalis</i>	Yellow-bellied Three-toed Skink	P	
<i>Tiliqua scincoides</i>	Common Bluetongue	P	
<i>Ramphotyphlops nigrescens</i>	Blackish Blind Snake	P	
<i>Morelia spilota spilota</i>	Diamond Python	P	
<i>Cacophis krefftii</i>	Dwarf Crowned Snake	P	
<i>Demansia psammophis</i>	Yellow-faced Whipsnake	P	
<i>Hemiaspis signata</i>	Marsh Snake	P	
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	P	
BIRDS			
<i>Coturnix chinensis</i>	King Quail	P	
<i>Coturnix pectoralis</i>	Stubble Quail	P	
<i>Coturnix ypsilophora</i>	Brown Quail	P	
<i>Anseranas semipalmata</i>	Magpie Goose	V	
<i>Anas castanea</i>	Chestnut Teal	P	X
<i>Anas gracilis</i>	Grey Teal	P	
<i>Anas platyrhynchos</i>	Mallard	U	
<i>Anas querquedula</i>	Garganey	P	
<i>Anas rhynchos</i>	Australasian Shoveler	P	
<i>Anas superciliosa</i>	Pacific Black Duck	P	
<i>Aythya australis</i>	Hardhead	P	
<i>Biziura lobata</i>	Musk Duck	P	
<i>Chenonetta jubata</i>	Australian Wood Duck	P	
<i>Cygnus atratus</i>	Black Swan	P	
<i>Dendrocygna arcuata</i>	Wandering Whistling-Duck	P	
<i>Dendrocygna eytoni</i>	Plumed Whistling-Duck	P	
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck	P	
<i>Oxyura australis</i>	Blue-billed Duck	V	
<i>Stictonetta naevosa</i>	Freckled Duck	V	
<i>Tadorna tadornoides</i>	Australian Shelduck	P	
<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe	P	
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	P	
<i>Pachyptila turtur</i>	Fairy Prion	P	
<i>Pterodroma solandri</i>	Providence Petrel	V	
<i>Puffinus gavia</i>	Fluttering Shearwater	P	
<i>Puffinus pacificus</i>	Wedge-tailed Shearwater	P	
<i>Puffinus tenuirostris</i>	Short-tailed Shearwater	P	
<i>Morus serrator</i>	Australasian Gannet	P	
<i>Anhinga melanogaster</i>	Darter	P	
<i>Phalacrocorax carbo</i>	Great Cormorant	P	X
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	P	
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	P	
<i>Phalacrocorax varius</i>	Pied Cormorant	P	
<i>Pelecanus conspicillatus</i>	Australian Pelican	P	X
<i>Ardea alba</i>	Great Egret	P	X
<i>Ardea ibis</i>	Cattle Egret	P	

Scientific Name	Common Name	Status	Umwelt Study
<i>Ardea intermedia</i>	Intermediate Egret	P	
<i>Ardea pacifica</i>	White-necked Heron	P	X
<i>Botaurus poiciloptilus</i>	Australasian Bittern	V	
<i>Butorides striatus</i>	Striated Heron	P	
<i>Egretta garzetta</i>	Little Egret	P	
<i>Egretta novaehollandiae</i>	White-faced Heron	P	X
<i>Ixobrychus flavicollis</i>	Black Bittern	V	
<i>Ixobrychus minutus</i>	Little Bittern	P	
<i>Nycticorax caledonicus</i>	Nankeen Night Heron	P	
<i>Platalea flavipes</i>	Yellow-billed Spoonbill	P	
<i>Platalea regia</i>	Royal Spoonbill	P	
<i>Plegadis falcinellus</i>	Glossy Ibis	P	
<i>Threskiornis molucca</i>	Australian White Ibis	P	
<i>Threskiornis spinicollis</i>	Straw-necked Ibis	P	
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	El	
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	P	
<i>Accipiter fasciatus</i>	Brown Goshawk	P	
<i>Accipiter novaehollandiae</i>	Grey Goshawk	P	
<i>Aquila audax</i>	Wedge-tailed Eagle	P	
<i>Aviceda subcristata</i>	Pacific Baza	P	
<i>Circus approximans</i>	Swamp Harrier	P	
<i>Elanus axillaris</i>	Black-shouldered Kite	P	X
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	P	
<i>Haliastur sphenurus</i>	Whistling Kite	P	
<i>Hieraaetus morphnoides</i>	Little Eagle	P	
<i>Lophoictinia isura</i>	Square-tailed Kite	V	
<i>Milvus migrans</i>	Black Kite	P	
<i>Pandion haliaetus</i>	Osprey	V	
<i>Falco berigora</i>	Brown Falcon	P	
<i>Falco cenchroides</i>	Nankeen Kestrel	P	
<i>Falco longipennis</i>	Australian Hobby	P	
<i>Falco peregrinus</i>	Peregrine Falcon	P	
<i>Falco subniger</i>	Black Falcon	P	
<i>Fulica atra</i>	Eurasian Coot	P	
<i>Gallinula tenebrosa</i>	Dusky Moorhen	P	
<i>Gallirallus philippensis</i>	Buff-banded Rail	P	
<i>Porphyrio porphyrio</i>	Purple Swampphen	P	
<i>Porzana fluminea</i>	Australian Spotted Crake	P	
<i>Porzana pusilla</i>	Baillon's Crake	P	
<i>Porzana tabuensis</i>	Spotless Crake	P	
<i>Rallus pectoralis</i>	Lewin's Rail	P	
<i>Turnix pyrrhotorax</i>	Red-chested Button-quail	P	
<i>Turnix varia</i>	Painted Button-quail	P	
<i>Actitis hypoleucos</i>	Common Sandpiper	P	
<i>Arenaria interpres</i>	Ruddy Turnstone	P	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	P	

Scientific Name	Common Name	Status	Umwelt Study
<i>Calidris canutus</i>	Red Knot	P	
<i>Calidris ferruginea</i>	Curlew Sandpiper	P	
<i>Calidris melanotos</i>	Pectoral Sandpiper	P	
<i>Calidris minuta</i>	Little Stint	P	
<i>Calidris ruficollis</i>	Red-necked Stint	P	
<i>Calidris tenuirostris</i>	Great Knot	V	
<i>Gallinago hardwickii</i>	Latham's Snipe	P	
<i>Heteroscelus brevipes</i>	Grey-tailed Tattler	P	
<i>Heteroscelus incanus</i>	Wandering Tattler	P	
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V	
<i>Limnodromus semipalmatus</i>	Asian Dowitcher	P	
<i>Limosa haemastica</i>	Hudsonian Godwit	P	
<i>Limosa lapponica</i>	Bar-tailed Godwit	P	
<i>Limosa limosa</i>	Black-tailed Godwit	V	
<i>Numenius madagascariensis</i>	Eastern Curlew	P	
<i>Numenius minutus</i>	Little Curlew	P	
<i>Numenius phaeopus</i>	Whimbrel	P	
<i>Philomachus pugnax</i>	Ruff	P	
<i>Tringa glareola</i>	Wood Sandpiper	P	
<i>Tringa nebularia</i>	Common Greenshank	P	
<i>Tringa stagnatilis</i>	Marsh Sandpiper	P	
<i>Tryngites subruficollis</i>	Buff-breasted Sandpiper	P	
<i>Xenus cinereus</i>	Terek Sandpiper	V	
<i>Irediparra gallinacea</i>	Comb-crested Jacana	V	
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1	
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V	
<i>Haematopus longirostris</i>	Pied Oystercatcher	V	
<i>Cladorhynchus leucocephalus</i>	Banded Stilt	P	
<i>Himantopus himantopus</i>	Black-winged Stilt	P	
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	P	
<i>Charadrius bicinctus</i>	Double-banded Plover	P	
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V	
<i>Charadrius mongolus</i>	Lesser Sand Plover	V	
<i>Charadrius ruficapillus</i>	Red-capped Plover	P	
<i>Charadrius veredus</i>	Oriental Plover	P	
<i>Elsyornis melanops</i>	Black-fronted Dotterel	P	
<i>Erythronyx cinctus</i>	Red-kneed Dotterel	P	
<i>Pluvialis dominica</i>	Lesser Golden Plover	P	
<i>Pluvialis fulva</i>	Pacific Golden Plover	P	
<i>Pluvialis squatarola</i>	Grey Plover	P	
<i>Vanellus miles</i>	Masked Lapwing	P	X
<i>Vanellus tricolor</i>	Banded Lapwing	P	
<i>Anous stolidus</i>	Common Noddy	P	
<i>Chlidonias hybridus</i>	Whiskered Tern	P	
<i>Chlidonias leucopterus</i>	White-winged Black Tern	P	
<i>Larus dominicanus</i>	Kelp Gull	P	

Scientific Name	Common Name	Status	Umwelt Study
<i>Larus novaehollandiae</i>	Silver Gull	P	X
<i>Stercorarius parasiticus</i>	Arctic Jaeger	P	
<i>Sterna albifrons</i>	Little Tern	E1	
<i>Sterna bergii</i>	Crested Tern	P	
<i>Sterna caspia</i>	Caspian Tern	P	
<i>Sterna hirundo</i>	Common Tern	P	
<i>Sterna nilotica</i>	Gull-billed Tern	P	
<i>Sterna striata</i>	White-fronted Tern	P	
<i>Chalcophaps indica</i>	Emerald Dove	P	
<i>Columba leucomela</i>	White-headed Pigeon	P	
<i>Columba livia</i>	Rock Dove	U	
<i>Geopelia humeralis</i>	Bar-shouldered Dove	P	
<i>Geopelia placida</i>	Peaceful Dove	P	
<i>Lopholaimus antarcticus</i>	Topknot Pigeon	P	
<i>Macropygia amboinensis</i>	Brown Cuckoo-Dove	P	
<i>Ocyphaps lophotes</i>	Crested Pigeon	P	
<i>Phaps elegans</i>	Brush Bronzewing	P	
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V	
<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	U	
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	P	
<i>Cacatua sanguinea</i>	Little Corella	P	
<i>Cacatua tenuirostris</i>	Long-billed Corella	P	
<i>Calyptrorhynchus funereus</i>	Yellow-tailed Black-Cockatoo	P	
<i>Eolophus roseicapillus</i>	Galah	P	
<i>Alisterus scapularis</i>	Australian King-Parrot	P	
<i>Glossopsitta pusilla</i>	Little Lorikeet	P	
<i>Lathamus discolor</i>	Swift Parrot	E1	
<i>Neophema pulchella</i>	Turquoise Parrot	V	
<i>Platycercus adscitus eximius</i>	Eastern Rosella	P	
<i>Platycercus elegans</i>	Crimson Rosella	P	
<i>Psephotus haematonotus</i>	Red-rumped Parrot	P	
<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	P	
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	P	
<i>Cacomantis variolosus</i>	Brush Cuckoo	P	
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo	P	
<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo	P	
<i>Cuculus pallidus</i>	Pallid Cuckoo	P	
<i>Cuculus saturatus</i>	Oriental Cuckoo	P	
<i>Eudynamys orientalis</i>	Pacific Koel	P	
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	P	
<i>Centropus phasianinus</i>	Pheasant Coucal	P	
<i>Ninox connivens</i>	Barking Owl	V	
<i>Ninox strenua</i>	Powerful Owl	V	
<i>Tyto alba</i>	Barn Owl	P	X

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<i>Tyto novaehollandiae</i>	Masked Owl	V	
<i>Podargus strigoides</i>	Tawny Frogmouth	P	
<i>Eurostopodus mystacalis</i>	White-throated Nightjar	P	
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	P	
<i>Apus pacificus</i>	Fork-tailed Swift	P	
<i>Alcedo azurea</i>	Azure Kingfisher	P	
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	P	
<i>Todiramphus macleayii</i>	Forest Kingfisher	P	
<i>Todiramphus sanctus</i>	Sacred Kingfisher	P	
<i>Eurystomus orientalis</i>	Dollarbird	P	
<i>Cormobates leucophaeus</i>	White-throated Treecreeper	P	
<i>Malurus cyaneus</i>	Superb Fairy-wren	P	
<i>Malurus lamberti</i>	Variegated Fairy-wren	P	
<i>Pardalotus punctatus</i>	Spotted Pardalote	P	
<i>Pardalotus striatus</i>	Striated Pardalote	P	
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	P	
<i>Acanthiza lineata</i>	Striated Thornbill	P	
<i>Acanthiza nana</i>	Yellow Thornbill	P	
<i>Acanthiza pusilla</i>	Brown Thornbill	P	
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	P	
<i>Gerygone levigaster</i>	Mangrove Gerygone	P	
<i>Gerygone mouki</i>	Brown Gerygone	P	
<i>Gerygone olivacea</i>	White-throated Gerygone	P	
<i>Sericornis frontalis</i>	White-browed Scrubwren	P	
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	P	
<i>Anthochaera carunculata</i>	Red Wattlebird	P	
<i>Anthochaera chrysoptera</i>	Little Wattlebird	P	
<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	P	
<i>Epthianura albifrons</i>	White-fronted Chat	P	
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	P	
<i>Lichenostomus leucotis</i>	White-eared Honeyeater	P	
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	P	
<i>Lichmera indistincta</i>	Brown Honeyeater	P	X
<i>Manorina melanocephala</i>	Noisy Miner	P	
<i>Manorina melanophrys</i>	Bell Miner	P	
<i>Meliphaga lewinii</i>	Lewin's Honeyeater	P	
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	P	
<i>Melithreptus lunatus</i>	White-naped Honeyeater	P	
<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	P	
<i>Philemon citreogularis</i>	Little Friarbird	P	
<i>Philemon corniculatus</i>	Noisy Friarbird	P	
<i>Phylidonyris nigra</i>	White-cheeked Honeyeater	P	
<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	P	
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E1	
<i>Eopsaltria australis</i>	Eastern Yellow Robin	P	
<i>Petroica boodang</i>	Scarlet Robin	P	

Scientific Name	Common Name	Status	Umwelt Study
<i>Petroica rosea</i>	Rose Robin	P	
<i>Psophodes olivaceus</i>	Eastern Whipbird	P	
<i>Daphoenositta chrysoptera</i>	Varied Sittella	P	
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	P	
<i>Falcunculus frontatus</i>	Eastern Shrike-tit	P	
<i>Pachycephala pectoralis</i>	Golden Whistler	P	
<i>Pachycephala rufiventris</i>	Rufous Whistler	P	
<i>Dicrurus bracteatus</i>	Spangled Drongo	P	
<i>Grallina cyanoleuca</i>	Magpie-lark	P	
<i>Monarcha melanopsis</i>	Black-faced Monarch	P	
<i>Monarcha trivirgatus</i>	Spectacled Monarch	P	
<i>Myiagra inquieta</i>	Restless Flycatcher	P	
<i>Rhipidura albiscapa</i>	Grey Fantail	P	
<i>Rhipidura leucophrys</i>	Willie Wagtail	P	
<i>Rhipidura rufifrons</i>	Rufous Fantail	P	
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	P	
<i>Coracina tenuirostris</i>	Cicadabird	P	
<i>Lalage tricolor</i>	White-winged Triller	P	
<i>Oriolus sagittatus</i>	Olive-backed Oriole	P	
<i>Artamus cyanopterus</i>	Dusky Woodswallow	P	
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	P	
<i>Cracticus nigrogularis</i>	Pied Butcherbird	P	
<i>Cracticus torquatus</i>	Grey Butcherbird	P	
<i>Gymnorhina tibicen</i>	Australian Magpie	P	
<i>Strepera graculina</i>	Pied Currawong	P	
<i>Corvus coronoides</i>	Australian Raven	P	
<i>Corvus orru</i>	Torresian Crow	P	
<i>Corcorax melanorhamphos</i>	White-winged Chough	P	
<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird	P	
<i>Sericulus chrysocephalus</i>	Regent Bowerbird	P	
<i>Anthus australis</i>	Australian Pipit	P	
<i>Motacilla flava</i>	Yellow Wagtail	P	
<i>Passer domesticus</i>	House Sparrow	U	
<i>Carduelis carduelis</i>	European Goldfinch	U	
<i>Lonchura castaneothorax</i>	Chestnut-breasted Mannikin	P	
<i>Lonchura punctulata</i>	Nutmeg Mannikin	U	
<i>Neochmia modesta</i>	Plum-headed Finch	P	
<i>Neochmia temporalis</i>	Red-browed Finch	P	
<i>Taeniopygia bichenovii</i>	Double-barred Finch	P	
<i>Taeniopygia guttata</i>	Zebra Finch	P	
<i>Dicaeum hirundinaceum</i>	Mistletoebird	P	
<i>Hirundo neoxena</i>	Welcome Swallow	P	
<i>Hirundo rustica</i>	Barn Swallow	P	
<i>Petrochelidon ariel</i>	Fairy Martin	P	
<i>Petrochelidon nigricans</i>	Tree Martin	P	
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	U	

Scientific Name	Common Name	Status	Umwelt Study
<i>Acrocephalus australis</i>	Australian Reed-Warbler	P	
<i>Cincloramphus cruralis</i>	Brown Songlark	P	
<i>Cincloramphus mathewsi</i>	Rufous Songlark	P	
<i>Cisticola exilis</i>	Golden-headed Cisticola	P	
<i>Megalurus gramineus</i>	Little Grassbird	P	
<i>Megalurus timoriensis</i>	Tawny Grassbird	P	
<i>Zosterops lateralis</i>	Silvereye	P	
<i>Turdus merula</i>	Eurasian Blackbird	U	
<i>Acridotheres tristis</i>	Common Myna	U	
<i>Sturnus vulgaris</i>	Common Starling	U	X
MAMMALS			
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	P	
<i>Antechinus stuartii</i>	Brown Antechinus	P	
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	
<i>Sminthopsis murina</i>	Common Dunnart	P	
<i>Isodon macrourus</i>	Northern Brown Bandicoot	P	
<i>Perameles nasuta</i>	Long-nosed Bandicoot	P	
<i>Phascolarctos cinereus</i>	Koala	V	
<i>Vombatus ursinus</i>	Common Wombat	P	
<i>Petaurus breviceps</i>	Sugar Glider	P	
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	P	
<i>Acrobates pygmaeus</i>	Feathertail Glider	P	
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	P	
<i>Macropus rufogriseus</i>	Red-necked Wallaby	P	
<i>Wallabia bicolor</i>	Swamp Wallaby	P	
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	
<i>Pteropus</i> sp.	Flying-fox	P	
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	
<i>Mormopterus loriae</i>	Little Northern Freetail-bat	P	
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	
<i>Mormopterus</i> sp 1	undescribed mastiff-bat	P	
<i>Mormopterus</i> sp 2	Little Freetail Bat	P	
<i>Nyctinomus australis</i>	White-striped Freetail-bat	P	
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	P	
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	P	
<i>Miniopterus australis</i>	Little Bentwing-bat	V	
<i>Miniopterus schreibersii</i>	Common Bentwing-bat	V	
<i>Myotis adversus</i>	Large-footed Myotis	V	
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	P	
<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	P	
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	P	
<i>Vespadelus pumilus</i>	Eastern Forest Bat	P	
<i>Vespadelus vulturnus</i>	Little Forest Bat	P	X

Scientific Name	Common Name	Status	Umwelt Study
<i>Mus musculus</i>	House Mouse	U	
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	P	
<i>Rattus fuscipes</i>	Bush Rat	P	
<i>Rattus lutreolus</i>	Swamp Rat	P	
<i>Rattus norvegicus</i>	Brown Rat	U	
<i>Rattus rattus</i>	Black Rat	U	
<i>Lepus capensis</i>	Brown Hare	U	
<i>Oryctolagus cuniculus</i>	Rabbit	U	
<i>Arctocephalus forsteri</i>	New Zealand Fur-seal	V	
<i>Arctocephalus</i> sp.	Unidentified Fur-seal	P	
<i>Seal</i> sp.	Unidentified Seal	P	
<i>Canis lupus</i>	Dingo, domestic dog	U	
<i>Vulpes vulpes</i>	Fox	U	
<i>Felis catus</i>	Cat	U	
<i>Dugong dugon</i>	Dugong	E1	
<i>Megaptera novaeangliae</i>	Humpback Whale	V	
<i>Kogia breviceps</i>	Pygmy Sperm Whale	P	
<i>Mesoplodon layardii</i>	Strap-toothed Beaked Whale	P	
<i>Delphinus delphis</i>	Common Dolphin	P	
<i>Stenella attenuata</i>	Spotted Dolphin	P	
<i>Equus caballus</i>	Horse	U	
<i>Bos taurus</i>	European cattle	U	

APPENDIX 3

Eight Part Tests

Eight Part Tests

1. An aquatic plant - *Zannichellia palustris*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

Zannichellia palustris was not recorded in the project area, however potential habitat is considered to exist in the freshwater swamp in the project area, in wetter periods when standing water would be present. The plant dies back completely each summer, therefore the November/ December timing of the vegetation surveys limited the likelihood of identifying the species.

Zannichellia palustris is a submerged monoecious weakly rhizomatous aquatic annual or perennial plant. The species occurs in fresh to brackish, still to slowly moving waters. It is known only from the Murray River estuary and the lower Hunter region. Recent collections have been made from Ironbark Creek, tributaries at Shortland and Wallsend, and in ponds on Kooragang Island. *Zannichellia palustris* behaves as an annual, and dies back completely each summer. Individual patches of the plant range from about 5m² to 100m², but vary from year to year (NPWS, 1997).

The species has recently been collected from several localities in the general vicinity of the project area. The potential habitat provided in the project area is of limited quality, as no standing water remains in times of drought such as when the survey for this report was undertaken, and the potential habitat is isolated from other freshwater habitat on Kooragang Island. Therefore, it is considered that the removal of this potential habitat would not disrupt the life cycle of the species such that a viable population is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of *Zannichellia palustris* is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of *Zannichellia palustris* is present in the project area, and therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

None of the known sites of *Zannichellia palustris* in NSW are formally protected, and none are managed in any way for the conservation of the species (NPWS, 1997).

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

Zannichellia palustris has a cosmopolitan distribution, but in Australia is known only from the Murray River estuary in South Australia and the lower Hunter region in NSW (NPWS, 1997). Therefore the species would not be at the limit of its known distribution if present in the project area.

2. Green and Golden Bell Frog – *Litoria aurea*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Green and Golden Bell Frog was not recorded in the project area despite comprehensive targeted surveys involving call-playback. However, potential habitat is considered to exist in the freshwater swamp in the project area.

The Green and Golden Bell Frog was formerly a commonly encountered species, well known to locals throughout its range. However, species numbers have dramatically declined in recent years to the stage where it is now listed as Endangered under the *Threatened Species Conservation Act, 1995*. The species typically occurs in large permanent swamps and ponds

with plenty of emergent vegetation, especially bullrushes. It is active by day and by night and will occasionally inhabit ornamental ponds and farm dams, where these occur close to preferred habitat areas (Robinson, 1995). The species has a distinctive call and is usually heard from August through to January (Robinson, 1995).

A comprehensive study into the habitat requirements of the Green and Golden Bell Frog by Pyke and White (1996) involved examining almost all known locations of the frog in NSW. The study determined that for a location to support a population of the Green and Golden Bell Frog in NSW it should have the following attributes:

- there should be a grassy area reasonably near to any water bodies, and other nearby vegetation should be woodland or lower in maximum height;
- the substrate should be sand (alluvial) or rock;
- the water bodies should be still, shallow, ephemeral and unpolluted. Such water bodies are most likely to occur in areas which experience disturbance (either natural or unnatural) and where surface water runoff from local unpolluted area collects to form temporary ponds;
- the water bodies should be unshaded and free of *Gambusia* and other predatory fish;
- there should be aquatic plants present, preferably *Typha* sp.; and
- there should be a range of possible diurnal shelter sites available, including vegetation and rocks.

Comprehensive targeted surveys were conducted in the project area in appropriate seasonal and weather conditions for the species to be detected (refer to **Section 2.2.3** of the main text). The species was not recorded during these surveys and is considered unlikely to occur in the project area as surveys were conducted at an optimum time for detection. The freshwater swamp in the project area is not considered to correspond to the preferred habitat of the species and more suitable habitat is located in other areas of Kooragang Island. Therefore the lifecycle of this species is not likely to be disrupted such that a viable population would be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of the Green and Golden Bell Frog is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of the Green and Golden Bell Frog is present in the project area, and therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

The Green and Golden Bell Frog has been recorded in Ben Boyd National Park, Botany Bay National Park, Hat Head National Park, Jervis Bay National Park, Kooragang Island Nature Reserve, Killalea State Recreation Area, Myall Lakes National Park, Nadgee Nature Reserve, Seven Mile Beach National Park and Towra Point Nature Reserve (NPWS, 1999j). However, it is considered that the Green and Golden Bell Frog is not adequately represented in conservation areas in the region.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The loss of suitable breeding habitat through the destruction of wetlands is a threat specific to the Green and Golden Bell Frog. The freshwater swamp located in the project area provides potential habitat, however no Green and Golden Bell Frog was observed in the swamp during a survey carried out in conditions optimal for detection. The proposal would involve the destruction of this potential habitat.

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Green and Golden Bell Frog is distributed in NSW from near Byron Bay in the north to the Victorian border in the south (White and Pyke, 1996). The species also occurs in the East Gippsland area of Victoria, extending from the border with NSW to Lake Wellington (Gillespie, 1996). Therefore the species would not be at the limit of its known distribution if present in the project area.

3. Australasian Bittern – *Botaurus poiciloptilus* and Black Bittern – *Ixobrychus flavicollis*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Australasian Bittern and Black Bittern were not recorded in the project area, despite surveys of the area at dusk, the time of day that these species are most active. However, the project area is considered to provide potential habitat for these species.

The Australasian Bittern inhabits terrestrial and estuarine wetlands, generally where there is permanent water. The species prefers wetlands with dense vegetation, including sedges, rushes and reeds. Freshwater is generally preferred, although dense saltmarsh vegetation in estuaries and flooded grasslands are also used by the species. During the day the Australasian Bittern roosts on the ground amongst dense reeds. At dusk the species forages in shallow water up to 30 cm deep, primarily feeding on frogs, fish, invertebrates, leaves and fruit. Although generally sedentary, the species often moves in response to flooding and drought. The nest is constructed of trampled reeds and rushes and is generally located amongst dense vegetation above shallow water (NPWS, 1999b).

The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, this species may occur in flooded grassland, forest, woodland, rainforest and mangroves. The Black Bittern forages on reptiles, fish and invertebrates, including dragonflies, shrimps and crayfish. Individuals generally feed at dusk and at night, and roost during the day in trees or on the ground amongst dense reeds. Nests may be located on a branch overhanging water and consist of a bed of sticks and reeds on a base of larger sticks (NPWS, 1999c).

Appropriate freshwater swamp, saltmarsh and mangrove habitat for these species is available only in small amounts in the project area. Furthermore, these habitats are highly disturbed by rubbish dumping, weed invasion, clearance of vegetation, and noise from Cormorant Road. It is considered unlikely that the project area provides significant resources to these species, particularly considering the proximity of higher quality habitat in Kooragang Nature Reserve and other surrounding areas. Therefore, it is considered that the removal of this potential habitat would not disrupt the life cycle of either of these species such that a viable population is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of the Australasian Bittern or Black Bittern is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of the Australasian Bittern or Black Bittern is present in the project area, and therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

The Australasian Bittern has been recorded in several conservation reserves in the region, including: Hexham Swamp Nature Reserve; Kooragang Nature Reserve; and Dharug National Park (NPWS, 1999b). It is considered unlikely that the species is adequately represented in conservation reserves in the region.

The Black Bittern has been recorded in several conservation reserves in the region, including: Blue Mountains National Park; Dharug National Park; Scheyville National Park; and Cattai National Park (NPWS, 1999c). It is considered unlikely that the species is adequately represented in conservation reserves in the region.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Australasian Bittern occurs from southern Queensland to Tasmania and south eastern South Australia, including most of NSW and Victoria (NPWS, 1999b). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Black Bittern has a wide distribution, from southern NSW to Cape York and along the entire northern coast to the Kimberley region (NPWS, 1999c). Therefore the species would not be at the limit of its known distribution if present in the project area.

4. Coastal Birds

Sooty Oystercatcher – *Haematopus fuliginosus*

Pied Oystercatcher – *Haematopus longirostris*

Little Tern – *Sterna albifrons*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Sooty Oystercatcher, Pied Oystercatcher and Little Tern were not recorded in the project area, despite comprehensive surveys of the area. However, the project area is considered to provide potential habitat for these species.

The Sooty Oystercatcher inhabits intertidal rocky and coral reefs, mostly on ocean shores, and breeds mostly on offshore islands. The species occasionally frequents sandspits and tidal mudflats, mostly when not breeding, and favours more rocky habitats than the Pied Oystercatcher. Breeds June to January. Nests in a depression in sand among rocks, seaweed, pigface and shells, usually on an island (Pizzey and Knight, 1997).

The Pied Oystercatcher inhabits undisturbed sandy, shellgrit or pebble beaches, sandspits and sandbars, tidal mudflats and estuaries, and coastal islands, usually well away from cover. Occasionally found on rocky reefs, rocky shores, rock-stacks, and brackish or saline wetlands. Also observed on grassy paddocks, golf-courses or parks near the coast, probing for worms in wet short grass. Breeds August to January. Nests in a shallow scrape in sand on an open beach or among low growth behind a beach (Pizzey and Knight, 1997).

The Little Tern is almost exclusively coastal with sheltered environments preferred. However, the species may also occur several kilometres from the sea in harbours, inlets and rivers. The Little Tern nests in small, scattered colonies on sandy beaches or shingle pits. The species is carnivorous, preferring small fish but also eating crustaceans, insects, annelids and molluscs. The species forages by plunging in the shallow water of channels and estuaries, and in the surf on beaches (NPWS, 1999).

Appropriate shoreline habitat for these species is available only in small quantity in the project area. Furthermore, these habitats are highly disturbed by rubbish dumping, weed invasion and noise from Cormorant Road. It is considered unlikely that the project area provides significant resources to these species, particularly considering the proximity of higher quality habitat in Kooragang Nature Reserve and other surrounding areas. Therefore, it is considered that the removal of this potential habitat would not disrupt the life cycle of any of these species such that a viable population is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of the Sooty Oystercatcher, Pied Oystercatcher or Little Tern is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of the Sooty Oystercatcher, Pied Oystercatcher or Little Tern is present in the project area, and therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

There is a lack of records for the Sooty Oystercatcher, Pied Oystercatcher and Little Tern, and it is highly unlikely that any of these species are adequately represented in conservation reserves in the region.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Sooty Oystercatcher and Pied Oystercatcher are distributed along the entire coastline of Australia, including Tasmania. The Pied Oystercatcher is a vagrant inland (Pizzey and Knight, 1997). Therefore these species would not be at the limit of their known distribution if present in the project area.

The Little Tern occurs from Shark Bay in Western Australia, around northern and eastern Australia, to the east coast of Tasmania and around to the Gulf of St Vincent in South Australia (NPWS, 1999e). Therefore the species would not be at the limit of its known distribution if present in the project area.

5. Waders

Great Knot – *Calidris tenuirostris*

Broad-billed Sandpiper – *Limicola falcinellus*

Black-tailed Godwit – *Limosa limosa*

Terek Sandpiper – *Xenus cinereus*

Greater Sand Plover – *Charadrius leschenaultii*

Lesser Sand Plover – *Charadrius mongolus*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Great Knot, Broad-billed Sandpiper, Black-tailed Godwit, Terek Sandpiper, Greater Sand Plover and Lesser Sand Plover were not recorded in the project area, despite comprehensive surveys of the area. However, the project area is considered to provide potential habitat for these species.

The Great Knot occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Individuals have often been recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. The Great Knot forages in mud for invertebrates. The species breeds in Siberia and migrates to Australia in large numbers from late August to early September. Most birds return north in March and April, however some birds may stay over winter in Australia (NPWS, 1999i).

The Broad-billed Sandpiper is known to favour estuarine mudflats, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms and within shallow freshwater lagoons. The intertidal mudflats along the north coast are preferred, particularly areas of soft mud on the seaward side of mangroves. In NSW, the species tends to favour intertidal sand and mudflats in estuaries. Feeding occurs in soft wet mud, often whilst wading, and prey includes insects crustaceans, worms, molluscs and seeds. The Broad-billed Sandpiper breeds in the Soviet Union between June and August and then migrates to Australia (NPWS, 1999f).

The Black-tailed Godwit is primarily found along the coast on sand spits, lagoons and mudflats. However, the species also occurs inland on mudflats and in those portions of large muddy lakes and swamps (freshwater or brackish) where the water is less than 10 cm deep during suitable conditions (i.e. receding water). Individuals have also been observed in wet meadows and sewerage treatment works. The diet of the Black-tailed Godwit includes a variety of invertebrates. The Black-tailed Godwit breeds in Mongolia and Siberia and visits Australia during the summer, arriving in August and leaving in March (NPWS, 1999d).

The Terek Sandpiper has been recorded on coastal mudflats, lagoons, creeks and estuaries. Records indicate that the species prefers muddy beaches near mangroves but may also be observed on rocky pools and coral reefs and occasionally up to 10 kilometres inland around brackish pools. A wide variety of invertebrates are eaten by the species. Typical feeding is

undertaken by moving rapidly and erratically over soft, wet mud, pecking or probing at the surface and sometimes chasing prey. The Terek Sandpiper breeds south of the Arctic and visits Australia from August to April (NPWS, 1999m).

The Greater Sand Plover is entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sandy beaches or rocky shores. Individuals have been recorded on inshore reefs, rock platforms, small rocky islands and sand cays on coral reefs. Occasional sightings have also been made on near-coastal salt lakes, brackish swamps, shallow freshwater wetlands and grassed paddocks. The species forages at low tide on wet ground, usually away from the water's edge. The species' diet includes insects, crustaceans and molluscs. The Greater Sand Plover breeds in central Asia from Armenia to the Aral Sea and moves further south to countries including Australia for the winter (NPWS, 1999h).

The Lesser Sand Plover is known to favour coastal environs including beaches, mudflats and mangroves. Within NSW, individuals have been observed on intertidal sand and mudflats in estuaries, or roosting on sandy beaches or rocky shores at high tide. The species forages on wet tidal flats, usually away from the water's edge. Their diet includes crustaceans, molluscs, insects and marine worms, although they have been recorded eating seeds. The Lesser Sand Plover breeds in the Northern Hemisphere and then migrates to the coasts of countries like Australia (NPWS, 1999k).

Habitat available in the project area is highly disturbed, and restricted to small areas of sandy shoreline, mangrove forest, saltmarsh and modified pasture. Larger and less disturbed areas of similar habitat are commonly available on Kooragang Island and in surrounding areas. The nearby North Arm of the Hunter River and Fullerton Cove provide significant feeding and roosting habitat for many migratory and non-migratory waders, and much of this habitat is protected within the Kooragang Nature Reserve. The habitat utilised in these areas consists of extensive intertidal mudflats and sandflats, and isolated roosting areas, which are much more suited to the requirements of waders than the limited resources of the project area. Therefore, it is considered that the removal of potential habitat in the project area would not disrupt the life cycle of any of these species of waders such that a viable population is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of the Great Knot, Broad-billed Sandpiper, Black-tailed Godwit, Terek Sandpiper, Greater Sand Plover or Lesser Sand Plover is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of the Great Knot, Broad-billed Sandpiper, Black-tailed Godwit, Terek Sandpiper, Greater Sand Plover or Lesser Sand Plover is present in the project area, and

therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

All of these waders have been recorded in Kooragang Nature Reserve. The Broad-billed Sandpiper has also been recorded in Ku-ring-gai Chase National Park and Royal National Park, and the Terek Sandpiper has been recorded in Royal National Park. It is considered highly unlikely that any of these species are adequately represented in conservation reserves in the region.

g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Great Knot has been recorded predominantly in coastal areas throughout Australia. In NSW, the species has been recorded in scattered sites along the coast south to Narooma (NPWS, 1999i). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Broad-billed Sandpiper is distributed over the northern coasts of Australia, particularly the north-west, with occasional birds seen on the southern coasts, and very few inland. In NSW, the main site for the species is the Hunter estuary with records along the coast south to the Shoalhaven estuary (NPWS, 1999f).

In NSW the Black-tailed Godwit has been regularly recorded only on Kooragang Island, however scattered sightings from both coastal and inland areas are usual (NPWS, 1999d). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Terek Sandpiper is found along the west, north and east coasts of Australia. In NSW, there are scattered records of the species along the coast from the Northern Rivers region south to the Lake Wollumboola area. The two main NSW sites for this species are the Hunter estuary and the Richmond estuary (NPWS, 1999m). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Greater Sand Plover is commonly recorded on the west coast of Australia, but is apparently rare on the east coast. In NSW, the species has been recorded in coastal areas from the northern rivers south to Shoalhaven Heads. The majority of the birds sighted in NSW have been recorded in the Clarence and Richmond Rivers (NPWS, 1999h). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Lesser Sand Plover occurs around the entire coastline of Australia but is most abundant in the Gulf of Carpentaria and along the east coast of Queensland and northern NSW (NPWS, 1999k). Therefore the species would not be at the limit of its known distribution if present in the project area.

6. Waterbirds

Magpie Goose – *Anseranas semipalmata*

Blue-billed Duck – *Oxyura australis*

Freckled Duck – *Stictonetta naevosa*

Black-necked Stork – *Ephippiorhynchus asiaticus*

Comb-crested Jacana – *Irediparra gallinacea*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Magpie Goose, Blue-billed Duck, Freckled Duck and Black-necked Stork were not recorded in the project area, despite comprehensive surveys of the area. However, the project area is considered to provide potential habitat for these species.

The Magpie Goose inhabits large seasonal wetlands and well-vegetated dams with rushes and sedges, wet grasslands and floodplains. Breeds July to November in south-east Australia. Nest consists of a deep cup on a mound of floating or trampled-down vegetation in a swamp (Pizzey and Knight, 1997).

The Blue-billed Duck is almost wholly aquatic and seldom seen on land. The species favours deep, permanent, well-vegetated swamps, especially those with beds of cumbungi *Typha* species. Non-breeding flocks, often totalling several hundred individuals, congregate on large, deep, open freshwater dams and lakes during autumn and winter. Daylight hours are spent alone in small, concealed bays within vegetation or communally in large exposed rafts far from shore. Breeding occurs in secluded, densely vegetated situations with the nest constructed in cumbungi beds or other vegetation, generally over water (NPWS, 1999e). The project area does not provide the deep water, or the large area of water that this species prefers.

The Freckled Duck inhabits a variety of plankton-rich wetland types, including swamps heavily vegetated with Cumbungi, Lignum, Canegrass or Ti-Tree (in coastal areas), large open lakes and their shores, creeks, farm dams, sewage ponds and floodwaters. The species feeds at wetland edges or in the shallow productive waters at dusk. They feed on algae, seeds

of various aquatic grasses and sedges, small invertebrates including crustaceans, zooplankton, worms, insects, small fish and the vegetative parts of aquatic plants (NPWS, 1999g).

The Black-necked Stork inhabits coastal wetlands, mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore-drains, sub-artesian pools, farm dams and sewage ponds. The species' nest consists of a large flat pile of sticks, grass and rushes, high and exposed in a tall live or dead tree (Pizzey and Knight, 1997).

The Comb-crested Jacana walks across the floating plants of permanent, well-vegetated wetlands and dams. It occasionally feeds along the muddy margins of a wetland. The species' nest consists of a low heap of wet, floating vegetation (Pizzey and Knight, 1997).

Appropriate freshwater swamp and mangrove habitat for these species is available only in small amounts in the project area. Furthermore, these habitats are highly disturbed by rubbish dumping, weed invasion, clearance of vegetation, and noise from Cormorant Road. It is considered unlikely that the project area provides significant resources to these species, particularly considering the proximity of higher quality habitat in Kooragang Nature Reserve and other surrounding areas. Therefore, it is considered that the removal of this potential habitat would not disrupt the life cycle of any of these species such that a viable population is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of the Magpie Goose, Blue-billed Duck, Freckled Duck, Black-necked Stork or Comb-crested Jacana is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of the Magpie Goose, Blue-billed Duck, Freckled Duck, Black-necked Stork or Comb-crested Jacana is present in the project area, and therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

There is a lack of records for the Magpie Goose, Blue-billed Duck, Black-necked Stork and Comb-crested Jacana, and it is highly unlikely that any of these species are adequately represented in conservation reserves in the region.

The Freckled Duck has been recorded in Kooragang Island Nature Reserve (NPWS, 1999g), but a lack of other records indicates that the species is not adequately represented in conservation reserves.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Magpie Goose was formally widespread in large numbers in south east Australia, but is now a casual visitor to NSW, Victoria and South Australia. The species' core distribution is now along the north coast from Broome to Brisbane. Therefore the species would not be at the limit of its known distribution if present in the project area.

The Blue-billed Duck occurs within temperate wetlands of the south-eastern and south-western parts of Australia (NPWS, 1999e). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Freckled Duck is endemic to south-eastern and south-western Australia (NPWS, 1999g). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Black-necked Stork has a core distribution in northern Australia, but has been recorded in eastern Australia as far south as Victoria, and inland to the Macquarie Marshes and Griffith (NPWS, 1999a). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Comb-crested Jacana is distributed across coastal north and eastern Australia, from Kimberley in Western Australia to the Hunter River. The species is recorded as a vagrant in Mudgee, the Sydney region, and the NSW south coast (Pizzey and Knight, 1997). Therefore the species would not be at the limit of its known distribution if present in the project area.

7. Osprey – *Pandion haliaetus*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Osprey was not recorded in the project area, however the portion of the South Arm of the Hunter River proposed for dredging is considered to provide potential foraging habitat for the species.

The Osprey inhabits coasts, estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons and rock cliffs and preys on fish. The species ascends large rivers (e.g. Murray River), and ventures far inland. The species' large nest consists of sticks, seaweed, and even rubbish such as rope, high in a tree or on a pylon, on an island the nest may be constructed on the ground (Pizzey and Knight, 1997). In New South Wales, the Osprey's breeding population is confined to the north and central coasts, north of Gosford (NPWS, 2000).

Ospreys need clean rivers, lakes, estuarine and inshore waters that support mullet, bream and other surface-dwelling school fish. They also need a nest site in a prominent, exposed position within a kilometre or two of their fishing grounds (NPWS, 2000).

The portion of the South Arm of the Hunter River proposed for dredging does provide potential foraging habitat for the Osprey. It is likely that during dredging works this habitat would not be utilised by Ospreys because of noise and localised reduced water quality. However, large areas of similar potential foraging habitat in the local area would be unaffected by the proposal, and it is expected that there would be no long-term adverse impact on foraging habitat in the dredging area. No large trees suitable for nesting are located in the project area. It is considered highly unlikely that the area to be impacted by the proposal provides significant resources to this species, considering the proximity of less disturbed habitat in surrounding areas. Therefore, it is considered that the temporary disturbance of this potential foraging habitat during dredging works would not disrupt the life cycle of this species such that a viable population is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which are relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat of the Osprey is present in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat of the Osprey is present in the project area and therefore the proposal would not result in an area of known habitat becoming isolated from other nearby areas.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

The Osprey has been recorded in Munmorah State Recreation Area and Tomaree National Park, but a lack of further records indicates that the species is not adequately represented in conservation reserves in the region.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Osprey is distributed along most of the Australian coastline, but is now rare or absent on the far south NSW coast, Victoria, Tasmania, Bass Strait and far south-east South Australia (Pizzey and Knight, 1997). Therefore the species would not be at the limit of its known distribution if present in the project area.

8. Grey-headed Flying Fox – *Pteropus poliocephalus*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Grey-headed Flying Fox was recorded flying high over the project area, but was not recorded in vegetation in the project area. The project area is considered to contain potential foraging habitat in the form of the Date Palms located next to the freshwater swamp. No potential roost sites are present in the project area.

The Grey-headed Flying Fox is a large flying fox that forages on a variety of flowering and fruiting plants, and is consequently responsible for the seed dispersal of many rainforest species. This species feeds on plants such as native figs and palms, banksias and eucalypts. Roost sites or 'camps' are located within gullies, typically not far from water, usually in vegetation with a dense canopy. Roost sites are important as these are the places where mating, birth and rearing of young occurs, in addition to providing daytime refuge from predators (Tidemann, 1998). A significant roost site is known to exist in Blackbutt Reserve, approximately 7 kilometres from the project area.

The proposal would result in the removal of a small amount of potential foraging habitat. However, this foraging habitat is of low quality and is not significant in a local or regional context. No roosting areas would be impacted by the proposal. Therefore the life cycle of the species would not be disrupted, and a viable population would not be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which is relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

The project area does not provide known habitat for the Grey-headed Flying Fox; several Grey-headed Flying Fox were observed flying high over the project area, but none was observed in vegetation in the project area. The proposal would not modify or remove an area of known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

The project area does not provide known habitat for the Grey-headed Flying Fox; several Grey-headed Flying Fox were observed flying high over the project area, but none was observed in vegetation in the project area. The proposed development would not act as a barrier to the movement of any locally occurring individuals. These species are highly mobile, and therefore their ability to disperse to adjacent habitat would be unaffected by the proposed development.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

The Grey-headed Flying Fox has been recorded in numerous conservation reserves along the east coast of New South Wales including the Barrington Tops National Park (NPWS, 2001). However, it is considered unlikely that the species is adequately represented in conservation reserves in the region.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Grey-headed Flying Fox is distributed along the coastal belt from Bundaberg in Queensland to Melbourne (NPWS, 2001). The species is not at the limit of its distribution in the project area.

9. Tree-roosting Microchiropteran Bats

Yellow-bellied Sheathtail Bat – *Saccolaimus flaviventris*

Eastern Freetail Bat – *Mormopterus norfolkensis*

Greater Broad-nosed Bat – *Scoteanax rueppellii*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, and Greater Broad-nosed Bat were not identified in the project area, however potential foraging habitat is present.

The Yellow-bellied Sheath-tail Bat is known to roost in tree hollows or other similar structures alone, or with up to 10 others. It hunts high above the forest canopy and in clearings. The species is usually solitary and is thought to be migratory in southern Australia (Richards, 1998b). Yellow-bellied Sheath-tail Bats are known from fewer than ten sites in the Hunter Region (Forest Fauna Surveys and Eastcoast Flora Surveys, 2001), although the species is distributed over much of eastern and northern Australia. Richards (1998b) considers the species to be rare in widespread habitat, and suggests that the apparent rarity of the species is probably due to its flying so high and fast that it is seldom collected. The Yellow-bellied Sheath-tail Bat has been recorded in dry forest habitat at Fern Bay (Clements & Associates, 1992).

The Eastern Freetail Bat is a fast flier, usually hunting above the forest canopy, but also taking insects on the ground. The species' habitat preferences are unclear, however most records are from dry eucalypt forest and woodland east of the Great Dividing Range, from southern New South Wales to southeastern Queensland. The species has also been recorded flying low over a rocky river through rainforest and wet sclerophyll forest. The Eastern Freetail Bat is predominantly tree-roosting, however it has been recorded roosting in a roof with other bat species. Little is known of the reproductive characteristics of the species; however, the capture of a number of females and no males at one site suggests that the sexes separate, perhaps for the birth and raising of young (Allison and Hoyer, 1998). The Eastern Freetail Bat has been recorded in mangrove habitat on Kooragang Island (Hoyer, 2002) and on Ash Island (Hoyer, unpub.).

The Greater Broad-nosed Bat preys on beetles and other large, slow-flying insects, flying slowly at a height of 3-6 metres. Recent evidence indicates that it also preys on other bats. The Greater Broad-nosed Bat is a tree hollow roosting species which inhabits the gullies and river systems draining the Great Dividing Range, but also extends to the coast over much of its range. Habitats range from woodland through to moist and dry Eucalypt forest to rainforest. Little is known of the reproductive cycle of the species; however, females congregate at maternity sites, located in suitable trees, where they appear to exclude males for the birth and raising of the single young in January (Hoyer and Richards, 1998). The Greater Broad-nosed Bat has been recorded in mangrove habitat on Kooragang Island (Hoyer, 2002) and in dry forest habitat at Fern Bay (Clements & Associates, 1992).

It is considered unlikely that the proposed development would have a significant impact on the life cycle of any of these threatened tree-roosting microchiropteran bat species, as similar and higher quality potential foraging habitat is present throughout the local area, and no tree hollows were identified in the project area. Therefore the proposed development would not disrupt the life cycle of these species such that a viable population would be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which is relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat for these threatened tree-roosting microchiropteran bat species is present in the project area. Therefore the proposal would not modify or remove known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat for these threatened tree-roosting microchiropteran bat species is present in the project area. Therefore the proposal would not isolate any area of known habitat.

The proposed development would not act as a barrier to the movement of any locally occurring individuals of these species. These species are highly mobile and are able to exploit the foraging resources of unaltered proximate vegetation communities.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) *Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

The conservation status of microchiropteran bats is inadequately known. The Eastern Freetail Bat and Greater Broad-nosed Bat have been recorded in low numbers in Wollemi and Barrington Tops National Parks (NPWS Website, accessed 30/01/03). The Greater Broad-nosed Bat has also been recorded in Yengo National Park, and the Eastern Freetail Bat in Tomaree National Park (NPWS Website, accessed 30/01/03). There are few records of the Yellow-bellied Sheathtail Bat in the region. It is considered unlikely that any of these species are adequately represented in conservation reserves in the region.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Yellow-bellied Sheathtail Bat is known to occur in all mainland states and territories. It is distributed throughout all of NSW and Victoria, and the majority of Queensland and the Northern Territory (Richards, 1998b). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Eastern Freetail Bat occurs throughout eastern Australia from Cooktown to southwest Victoria, and inland to the western slopes of the Great Dividing Range (Menkhorst and Knight, 2001). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Greater Broad-nosed Bat occurs from the Atherton Tableland in tropical Queensland to northeastern Victoria, with the species' stronghold in the gullies and river systems of the Great Dividing Range (Hoye and Richards, 1998). Therefore the species would not be at the limit of its known distribution if present in the project area.

10. Threatened Cave-roosting Microchiropteran Bats

Large-eared Pied Bat – *Chalinolobus dwyeri*

Little Bent-wing Bat – *Miniopterus australis*

Common Bent-wing Bat – *Miniopterus schreibersii*

Large-footed Myotis – *Myotis adversus*

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.*

The Large-eared Pied Bat, Little Bent-wing Bat, Common Bent-wing Bat and Large-footed Myotis were not identified in the project area, however potential foraging habitat is present.

The Large-eared Pied Bat typically roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. It is found in a variety of drier habitats, including dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Isolated records from sub-alpine woodland and at the edge of rainforest and moist eucalypt forest suggest that the species may occupy a greater diversity of habitats than has so far been recorded. It probably forages for small insects below the forest canopy (Hoye and Dwyer, 1998). The Large-eared Pied Bat has been recorded in mangrove forest on Kooragang Island approximately 2.5 kilometres to the north-east of the project area (Hoye, 2002).

The Little Bent-wing Bat is an obligate cave dweller, known to roost in caves, mine shafts and adits, tunnels and culverts. The species forages for small insects beneath the canopy of well-timbered habitats including rainforest, *Melaleuca* swamps and dry sclerophyll forests. Towards the southern limit of the species' range, on the NSW central coast, it becomes increasingly coastal. The species relies upon a small number of nursery sites to rear its young. It frequently roosts with the Common Bent-wing Bat, and may form mixed clusters within which the warmth produced by the larger bats benefits the Little Bent-wing Bat (Dwyer, 1998b). The Little Bent-wing Bat has been recorded in mangrove forest on Kooragang Island approximately 2.5 kilometres to the north-east of the project area (Hoye, 2002).

The Common Bent-wing Bat is a cave-roosting species, known to rest in old mines, stormwater channels and comparable structures including occasional buildings. Typically, it is found in well-timbered valleys where it forages above the tree canopy on small insects. At the beginning of spring, adult females move from scattered roosts to specific nursery caves that retain or provide high temperature and humidity. Disturbance of these nursery caves may place the survival of widespread populations in jeopardy. The species is also vulnerable to disturbance of roosts used for hibernation, with frequent disturbance increasing winter mortality (Dwyer, 1998a). Dwyer (1998a) regards the species as abundant. The Common

Bent-wing Bat has been recorded in mangrove forest on Kooragang Island approximately 2.5 kilometres to the north-east of the project area (Hoye, 2002).

The Large-footed Myotis roosts in caves, mines or tunnels, under bridges and buildings and even in dense foliage in the tropical part of its range (Richards, 1998a). The species usually occurs in association with water bodies, ranging from rainforest streams to large lakes and reservoirs. The large-footed Myotis catches aquatic insects, which makes up most of its diet, raking the water surface with its large feet. The species is torpid in winter, remaining in roosts that are separate from the maternity sites, with young born in November or December each year in NSW (Richards, 1998a). The male Large-footed Myotis is known to roost alone when not breeding. The Large-footed Myotis has been recorded in mangrove forest on Kooragang Island approximately 2.5 kilometres to the north-east of the project area (Hoye, 2002).

It is considered unlikely that the proposed development would have a significant impact on the life cycle of any of these threatened cave-roosting microchiropteran bat species, as similar and higher quality potential foraging habitat is present throughout the local area, and no caves or other potential roosting habitat were identified in the project area. Therefore the proposed development would not disrupt the life cycle of these species such that a viable population would be placed at risk of extinction.

- b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

Currently, only a few specific populations have been identified as endangered under the *Threatened Species Conservation Act 1995*, none of which is relevant to the project area.

- c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

No known habitat for these threatened cave-roosting microchiropteran bat species is present in the project area. Therefore the proposal would not modify or remove known habitat.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas for a threatened species population or ecological community.*

No known habitat for these threatened tree-roosting microchiropteran bat species is present in the project area. Therefore the proposal would not isolate any area of known habitat.

The proposed development would not act as a barrier to the movement of any locally occurring individuals of these species. These species are highly mobile and are able to exploit the foraging resources of unaltered proximate vegetation communities.

- e) *Whether critical habitat will be affected.*

No areas of critical habitat designated under the *Threatened Species Conservation Act 1995* are located within this area of the state.

- f) Whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region.*

The conservation status of cave-roosting microchiropteran bats is inadequately known. One recording of the Large-eared Pied Bat has been made in Yengo National Park, one in the Watagans National Park, and 18 recordings have been made in Wollemi National Park (NPWS Website, accessed 31/01/03).

The Little Bent-wing Bat has been recorded in Lake Macquarie State Recreation Area and in Wollemi NP (NPWS Website, accessed 31/01/03).

The Common Bent-wing Bat has been recorded in low numbers in the Barrington Tops, Wollemi and Yengo National Parks and the Lake Macquarie and Munmorah State Recreation Areas (NPWS Website, accessed 31/01/03). An over-winter roost of this species occurs at Pilchers Hill Nature Reserve near Dungog, while other roosts occur in abandoned mines in Copeland Tops Flora Reserve (Forest Fauna Surveys and Eastcoast Flora Surveys, 2001).

The Large-footed Myotis has been recorded twice in Wollemi National Park (NPWS Website, accessed 31/01/03).

Available records indicate that these threatened cave-roosting microchiropteran bats are not adequately represented in conservation reserves in the region.

- g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation that results in a loss of biodiversity has been listed as a key threatening process. The artificial, reclaimed nature of the project area means that much of the native vegetation present is highly disturbed and does not comprise a full complement of local species. The vegetation is not unique in the local area, with similar vegetation located both in the local area and region, and no threatened species were identified. Therefore the loss of this vegetation would not result in a loss of biodiversity.

Alteration to the natural flow regimes of rivers and streams, and their floodplains and wetlands is recognized as a major factor contributing to loss of biological diversity and ecological function in aquatic systems, including floodplains. The dredging of the South Arm is not expected to alter the natural flow regime of the river to an extent which would have a significant impact on surrounding wetland areas. GHD advise that the final dredging profile does very little to alter the tidal hydrodynamics of the Hunter Estuary (refer to **Section 5.4.2.1** of the Flora and Fauna report for further details).

- h) Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Large-eared Pied Bat occurs from near Rockhampton in central coastal Queensland to Bungonia in southern New South Wales (Hoye and Dwyer, 1998). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Little Bent-wing Bat occurs in the coastal strip from Cape York to central NSW (Dwyer, 1998b). The species would be considered to be near the southern limit of its known distribution if present in the project area.

The Common Bent-wing Bat occurs throughout the coastal strip of Eastern Australia, extending from Cape York to Adelaide. The species is also found in the northern regions of

the Northern Territory and Western Australia (Dwyer, 1998a). Therefore the species would not be at the limit of its known distribution if present in the project area.

The Large-footed Myotis is found along the northern and eastern coasts of Australian from northwestern Western Australia to southeastern South Australia (Richards, 1998a). Therefore the species would not be at the limit of its known distribution if present in the project area.

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APPENDIX 4

Migratory Bird List

Migratory Species List

The following table lists the migratory species (as defined in the EPBC Act) previously recorded within 10 km of the project area in the National Parks and Wildlife Service Atlas of NSW Wildlife. The list of species represents the range of species that may potentially occur within the project area.

Scientific Name	Common Name
<i>Anas castanea</i>	Chestnut Teal
<i>Anas gracilis</i>	Grey Teal
<i>Anas platyrhynchos</i>	Mallard
<i>Anas querquedula</i>	Garganey
<i>Anas rhynchotis</i>	Australasian Shoveler
<i>Anas superciliosa</i>	Pacific Black Duck
<i>Aythya australis</i>	Hardhead
<i>Biziura lobata</i>	Musk Duck
<i>Chenonetta jubata</i>	Australian Wood Duck
<i>Cygnus atratus</i>	Black Swan
<i>Dendrocygna arcuata</i>	Wandering Whistling-Duck
<i>Dendrocygna eytoni</i>	Plumed Whistling-Duck
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck
<i>Oxyura australis</i>	Blue-billed Duck
<i>Stictonetta naevosa</i>	Freckled Duck
<i>Tadorna tadornoides</i>	Australian Shelduck
<i>Puffinus pacificus</i>	Wedge-tailed Shearwater
<i>Puffinus tenuirostris</i>	Short-tailed Shearwater
<i>Ardea alba</i>	Great Egret
<i>Ardea ibis</i>	Cattle Egret
<i>Plegadis falcinellus</i>	Glossy Ibis
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk
<i>Accipiter fasciatus</i>	Brown Goshawk
<i>Accipiter novaehollandiae</i>	Grey Goshawk
<i>Aquila audax</i>	Wedge-tailed Eagle
<i>Aviceda subcristata</i>	Pacific Baza
<i>Circus approximans</i>	Swamp Harrier
<i>Elanus axillaris</i>	Black-shouldered Kite
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle
<i>Haliastur sphenurus</i>	Whistling Kite
<i>Hieraaetus morphnoides</i>	Little Eagle
<i>Lophoictinia isura</i>	Square-tailed Kite
<i>Milvus migrans</i>	Black Kite
<i>Pandion haliaetus</i>	Osprey
<i>Falco berigora</i>	Brown Falcon
<i>Falco cenchroides</i>	Nankeen Kestrel
<i>Falco longipennis</i>	Australian Hobby

Scientific Name	Common Name
<i>Falco peregrinus</i>	Peregrine Falcon
<i>Falco subniger</i>	Black Falcon
<i>Arenaria interpres</i>	Ruddy Turnstone
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper
<i>Calidris canutus</i>	Red Knot
<i>Calidris ferruginea</i>	Curlew Sandpiper
<i>Calidris melanotos</i>	Pectoral Sandpiper
<i>Calidris minuta</i>	Little Stint
<i>Calidris ruficollis</i>	Red-necked Stint
<i>Calidris tenuirostris</i>	Great Knot
<i>Gallinago hardwickii</i>	Latham's Snipe
<i>Heteroscelus brevipes</i>	Grey-tailed Tattler
<i>Heteroscelus incanus</i>	Wandering Tattler
<i>Limicola falcinellus</i>	Broad-billed Sandpiper
<i>Limnodromus semipalmatus</i>	Asian Dowitcher
<i>Limosa lapponica</i>	Bar-tailed Godwit
<i>Limosa limosa</i>	Black-tailed Godwit
<i>Numenius madagascariensis</i>	Eastern Curlew
<i>Numenius minutus</i>	Little Curlew
<i>Numenius phaeopus</i>	Whimbrel
<i>Philomachus pugnax</i>	Ruff
<i>Tringa glareola</i>	Wood Sandpiper
<i>Tringa nebularia</i>	Common Greenshank
<i>Tringa stagnatilis</i>	Marsh Sandpiper
<i>Tryngites subruficollis</i>	Buff-breasted Sandpiper
<i>Xenus cinereus</i>	Terek Sandpiper
<i>Cladorhynchus leucocephalus</i>	Banded Stilt
<i>Himantopus himantopus</i>	Black-winged Stilt
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet
<i>Charadrius bicinctus</i>	Double-banded Plover
<i>Charadrius leschenaultii</i>	Greater Sand Plover
<i>Charadrius mongolus</i>	Lesser Sand (Mongolian) Plover
<i>Charadrius ruficapillus</i>	Red-capped Plover
<i>Charadrius veredus</i>	Oriental Plover
<i>Elseyornis melanops</i>	Black-fronted Dotterel
<i>Erythronyx cinctus</i>	Red-kneed Dotterel
<i>Pluvialis dominica</i>	Lesser Golden Plover
<i>Pluvialis fulva</i>	Pacific Golden Plover
<i>Pluvialis squatarola</i>	Grey Plover
<i>Vanellus miles</i>	Masked Lapwing
<i>Vanellus tricolor</i>	Banded Lapwing
<i>Anous stolidus</i>	Common Noddy
<i>Chlidonias leucopterus</i>	White-winged Black Tern
<i>Stercorarius parasiticus</i>	Arctic Jaeger
<i>Sterna albifrons</i>	Little Tern

Scientific Name	Common Name
<i>Sterna caspia</i>	Caspian Tern
<i>Sterna hirundo</i>	Common Tern
<i>Cuculus saturatus</i>	Oriental Cuckoo
<i>Apus pacificus</i>	Fork-tailed Swift
<i>Motacilla flava</i>	Yellow Wagtail
<i>Hirundo rustica</i>	Barn Swallow
<i>Acrocephalus australis</i>	Australian Reed-Warbler