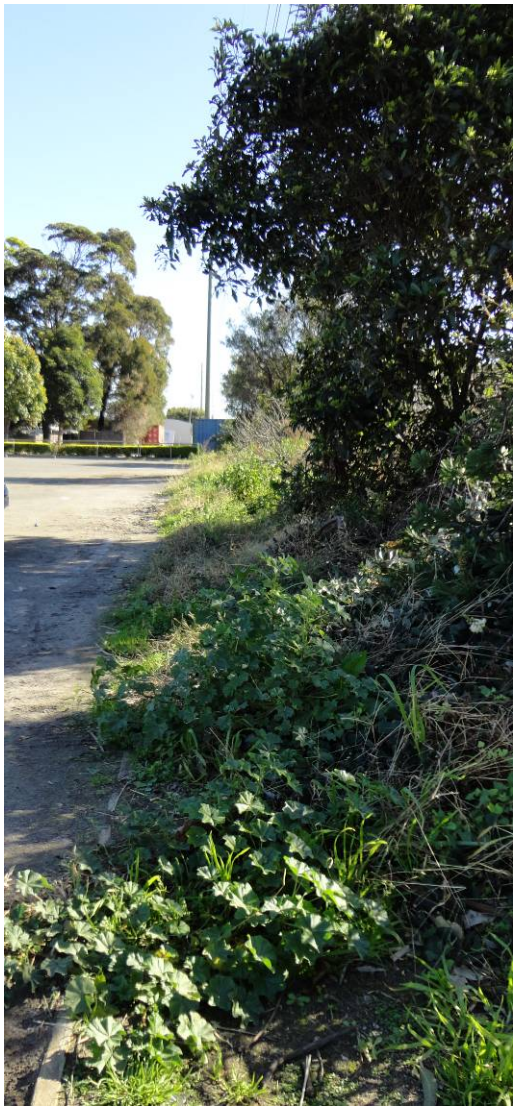
# CRONULLA SHARKS REDEVELOPMENT

## Ecological assessment of the concept plan

Prepared for
**Bluestone Capital Ventures No. 1 Pty Ltd**

29 July 2011



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# Executive Summary

An ecological assessment of the proposed Cronulla Sharks redevelopment concept plan has been conducted by Eco Logical Australia Pty Ltd on behalf of Bluestone Capital Ventures No.1 Pty Ltd.

The subject site comprises Lot 11 DP 526492, Lot 20 DP 529644, Lot 1 DP 711486, Lot 21 DP 529644 and Lot 1 DP 501920, being a 10 ha site located at 461 Captain Cook Drive, Woolooware. The site is positioned on the southern shore of Woolooware Bay, adjacent a significant corridor of mangroves that connect to the Taren Point Shorebird Reserve and Towra Point Nature Reserve and Aquatic Reserve.

Prior to the 1950s, the subject site was part of an extensive estuarine ecosystem. The site was filled with non-putrescible waste between the 1950s and 1970s. The subject site is currently occupied by:

- A bitumen carpark to the edge of mangroves in Woolooware Bay (eastern land)
- The Cronulla Sharks Leagues Club and stadium (Toyota Stadium)
- A bitumen carpark, and two turfed playing fields to the edge of mangroves (western land)
- A narrow strip of land on the edge of the mangroves that is owned by Sutherland Shire Council

The subject site currently has little ecological value as a result of past landfill, subsequent development and weed infestation. A channel on the western side of the stadium supports mangroves and associated biota, and connects Woolooware Bay to areas on the southern side of Captain Cook Drive.

The proposed retail and residential development will feature a landscaped zone on the northern margin. It will incorporate a pedestrian/cycleway for its entire length, as well as playground and picnic areas on the western lands. Landscaping will also be introduced on the western side of the channel and as part of the streetscape.

The proposed landscaping on the northern margin aims to replicate a succession of mangrove – coastal saltmarsh – swamp oak floodplain forest communities using local provenance species. This would represent a significant improvement on current conditions within the subject site.

The assessment found that the proposed development is unlikely to have a significant effect on threatened species, populations, ecological communities or their habitats, and accordingly a Species Impact Statement is not required for the proposal. However, further assessment will be needed for detailed design and management planning purposes to determine potential impacts on ecosystems in the channel and adjacent mangroves resulting from changes to stormwater management.

Recommendations include:

- Further investigation and assessment of water quality and flooding
- Preparation and implementation of detailed design as well as management plans to address light/shadow, waste, soil, water and vegetation
- Development of community education programs, including signage to reduce the risk of adverse behaviours such as rubbish dumping and trampling
- Commitment to ongoing control of weeds, rubbish and adaptive management of native vegetation in the landscaped zone

# 1 Introduction

## 1.1 BACKGROUND

Cronulla Sutherland District Rugby League Football Club (hereafter known as Cronulla Sharks) is the owner of Lot 11 DP 526492 and Lot 20 DP 529644, being a 10 ha site located at 461 Captain Cook Drive, Woolooware (**Figure 1**). The site is currently occupied by the licensed Cronulla Sharks Leagues Club, Toyota Stadium, and car parking and training facilities. The site is within the Sutherland Shire local government area.

Cronulla Sharks proposes to redevelop the site for a mixed use neighbourhood retail centre and residential master-planned estate. The existing leagues club and stadium will continue to operate at the site. Concept plans for the proposed development are given in **Appendix A**.

Eco Logical Australia Pty Ltd has been engaged by Bluestone Capital Ventures No.1 Pty Ltd (acting on behalf of the proponent, Cronulla Sharks) to prepare a flora and fauna assessment of the proposed redevelopment. This assessment will be submitted as part of a Part 3A Concept Plan Application under the NSW *Environmental Planning and Assessment Act 1979*.

## 1.2 THE PROPOSAL

The proposed development relates to three main areas within the overall landholding owned by the Cronulla Sharks. For the purpose of this study, the subject land is referred to as:

- The eastern land (part of Lot 11 DP 526492) - approximately 3.04 ha including part of the existing licensed Sharks Leagues Club building and hardstand car parking area
- Toyota Stadium (part of Lot 11 DP 526492) – an area of 2.84 ha comprising the majority of the Sharks Leagues Club building, the football field, spectator stadiums and facilities
- The western land (Lot 20 DP 529644) - an area of approximately 4.12 ha comprising an existing hardstand car parking, two grassed playing fields and club house facilities
- The narrow strip of land on the edge of the mangroves (Lot 1 DP 711486 and Lot 21 DP 529644), and roundabout intersection of Captain Cook Drive and Woolooware Road (Lot 1 DP 501920) – Bluestone Capital Ventures No.1 Pty Ltd has the owner's (Sutherland Shire Council's) consent to lodge a concept plan for future development of these lots

A brief description of proposed developments on these areas is given below, with the concept plan provided in **Appendix A**.

### 1.2.1 Eastern land

It is proposed that the carpark will be redeveloped into a three storey retail centre consisting of supermarket, medical facility and other retail facilities. The loading dock will be positioned on the north-eastern corner of the building to provide easy access to an extended Woolooware Road. A landscaped area, including a pedestrian/bike path and rock sea wall, will be created between the building and mangroves, to stabilise the steep embankment, and improve habitat and amenity.


**Figure 1: Cronulla Sharks development site (the subject site)**

Rainfall onto the landscaped area on the northern margin will be taken up by planted vegetation or flow into Woolooware Bay after percolating to groundwater or becoming surface runoff. Rainfall onto the roof of the retail centre will be collected in tanks and transferred via stormwater pipes and a gross pollutant trap into the southern end of the existing channel on the western side of the stadium prior to discharging to the bay. Final details of stormwater management (e.g. flow volumes, water quality and required infrastructure) have not been determined for the concept plan.

### 1.2.2 Toyota Stadium

Redevelopment of Toyota Stadium will include an extension of the existing building complex on the eastern side, including a leisure breakout area and retail courtyard. The northern portion of the oval (known as the 'Family Hill') will be lowered by approximately 1 m and terraced. The area on the north-facing side of the hill up to the edge of the mangroves will be revegetated and stabilised, and a pedestrian/cycle path will be constructed.

### 1.2.3 Western land

The existing grassed playing fields and bitumen carpark on the western lands will be redeveloped to provide approximately 700 residential units in a residential estate occupying 4.2 ha. There will be eight buildings ranging from two to fourteen storeys above podium. A landscaped zone will be provided over the northern part of the site consisting of a landscaped playground, barbeque/picnic area and turf area. The landscaped zone will contain boardwalks with educational platforms as well as planting with native vegetation.

Stormwater runoff from the proposed residential area will be treated by a bioretention swale adjacent to the existing channel, prior to discharging to the channel via pipes. Rainfall onto the proposed landscaped zone to the north of the residential area will be taken up by planted vegetation or enter the bay as groundwater or surface runoff.

### 1.2.4 Landscaping

Proposed landscaping features are illustrated in the concept plan in **Appendix A**. Design elements include:

- Planting with local provenance native species to replicate estuarine edge succession on the margins of the mangroves
- Planting with local provenance native species for street landscaping
- New pedestrian path/cycleway to link with the existing cycleway to the west
- Replacement boardwalk in the same location as the existing boardwalk through the mangroves
- Landscaped zone between the edge of the mangroves and the retail building complex on the eastern side to include cycleway and boardwalk access
- Landscaping in the retail courtyard and leisure breakout area
- Slope stabilisation and landscaping on the northern side of the stadium, including construction of a path/cycleway and seawall along the edge of the mangroves
- Landscaped zone on the western side between the edge of the mangroves and the residential buildings to include cycleway plus playground, BBQ/picnic area and open space turfed area
- Landscaped zone from the edge of the mangrove channel to the residential buildings on the western side to include a bioretention swale and sealed path which will be used for truck parking during Sharks' games

### 1.2.5 Construction

It is estimated that it will take approximately seven years to construct the proposed development. No details are currently available regarding the scheduling of works or construction techniques.

## 1.3 DIRECTOR-GENERAL'S REQUIREMENTS

Director-General's requirements for the Concept Plan Application MP10_0229 (issued on 25 March 2011) have been issued for the flora and fauna assessment, as follows:

- *Assess the impact on flora and fauna, including threatened species, populations and endangered ecological communities and their habitats and steps taken to mitigate any identified impacts to protect the environment, both marine and land in accordance with 'DECC Threatened species assessment guideline 2007'. Including a detailed survey of migratory bird habitat and determine whether and how they are using the site and adjoining areas, and asses any potential impacts or threats to the population.*
- *Assess and consult with the Commonwealth regarding any triggers for assessment and approval under the EPBC Act 1999.*
- *Provide a description of mitigation and management options that will be used to prevent, control, abate or minimise identified impacts on Towra Point Aquatic Reserve.*
- *Provide a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity native vegetation and habitat.*
- *Address the protection and enhancement of riparian land along the southern shore of Woolooware Bay and watercourse on the site and assess and provide details of all watercourses and riparian land on the site. Including assessing potential impacts, areas of disturbance and safeguard measures to mitigate impacts, contingency plans for remediation and rehabilitation of riparian areas in the event of potential adverse impacts and long term management of riparian lands.*
- *Demonstrate compliance with the NSW Office of Waters guideline for controlled activities and outline the provision of a 40m wide core riparian zone.*

## 1.4 REPORT OBJECTIVES

The objectives of this report are to use previous ecological studies and information prepared for the concept plan to:

- Describe the existing flora and fauna on the development site as well as adjacent lands via database searches, site reconnaissance and surveys completed within the last five years
- Consider the likely impacts on the ecology of the region due to the proposed development, including the assessment of threatened species as outlined by relevant DECC guidelines
- Assess potential impacts on the riparian zone, surrounding foreshore areas and aquatic habitats
- Provide preliminary advice regarding possible mitigation measures and recommendations for further assessment

No consideration has been given to matters of national significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In response to a separate submission by Bluestone Capital Ventures No.1, the Commonwealth has advised that the proposed redevelopment is not a 'controlled action' and no further approvals are required under the EPBC Act. Notification of the referral decision is given in **Appendix B**.

# 2 The site

## 2.1 SUBJECT SITE AND STUDY AREA

The boundaries of the *subject site* are defined by the cadastre of land owned by Cronulla Sharks, as well as Lot 1 DP 711486 and Lot 21 DP 529644 (which are currently owned by Council and define the northern boundary of the subject site). The eastern boundary is a road reserve for Woolooware Road, and the western boundary is the Council owned carpark and playing field associated with Solander Oval. The southern boundary of the site is adjacent to Captain Cook Drive, with Captain Cook playing fields and Woolooware golf course further to the south.

The subject site encompasses an area of approximately 10 ha and it falls within the following longitude and latitude points (**Table 1**).

**Table 1: Location of subject site in longitude and latitude**

| LOCATION | LATITUDE | | | LONGITUDE | | |
|---|---|---|---|---|---|---|
| | Degrees | Minutes | Seconds | Degrees | Minutes | Seconds |
| South west | -34 | 2 | 20 | 151 | 8 | 15 |
| South east | -34 | 2 | 16 | 151 | 8 | 36 |
| North east | -34 | 2 | 20 | 151 | 8 | 35 |
| North west | -34 | 2 | 23 | 151 | 8 | 16 |

The *study area* (**Figure 2)** is defined in accordance with the DECC 2007 guidelines as the subject site plus any additional areas which are likely to be directly or indirectly affected by the proposal. The study area extends as far as is necessary to take all potential impacts into account. The study area maintains a large cross-section of habitats within Taren Point Shorebird Reserve, the Towra Point Nature Reserve and Aquatic Reserve[1]; estuarine ecosystems associated with Georges River and Botany Bay; as well as urban landscapes.

[1] Towra Point Nature Reserve is a wetland of local, national and international importance comprising mudflats, saltmarsh and mangrove forest. Towra Point is listed as a RAMSAR wetland (meaning, a wetland included in an international treaty for its preservation and protection) and is frequented by international migratory species (JAMBA and CAMBA) and breeding habitat for significant species. Towra Point Nature Reserve covers an area of 286.4 ha (SSEC 2004) and is linked to the subject site by a corridor created by grey river mangrove forest and coastal saltmarsh communities. The areas of aquatic habitat within Woolooware Bay are protected under the Towra Point Aquatic Reserve.


**Figure 2: Study area**

## 2.2 SITE HISTORY

As shown in the historical photos in **Appendix C**, prior to the 1950s the subject site and surrounds were covered by estuarine vegetation such as mangroves, saltmarsh and swamp oak floodplain forest. Between the 1950s and 1970s the site was backfilled with non-putrescible waste to be 'reclaimed'. The site was sold to the Cronulla Sharks in 1968, with the agreement that Sutherland Shire Council would fill the remainder of the site and then transfer management to the Sharks (EIS 2011).

The current ground surfaces on the eastern and western lands were established by the late 1970s. Toyota Stadium and associated facilities have been progressively developed by Cronulla Sharks since the 1970s.

In 2009, the Council granted development consent for a five storey aged care facility, three storey hotel, supermarket and extension to the club on the eastern land. However, the Cronulla Sharks consider this development not to be commercially viable and believe it does not utilise the full potential of the landholding. The Cronulla Sharks believe that the current proposal is more likely to provide a long term sustainable and financial gain for the club as well as providing substantial benefits to the community. (JBA 2010)

## 2.3 SOILS, GEOLOGY & GROUNDWATER

This section summarises the results of a study by EIS (2011) for the proposed development based on a desktop review of past geotechnical investigations that are tabulated below.

**Table 2: Previous geotechnical studies by EIS at 461 Captain Cook Drive, Woolooware**

| REPORT NAME | DATE | SITE | # BOREHOLES | RELEVANT DETAILS |
|---|---|---|---|---|
| Report to St George Partnership Banking Ltd, Environmental Site Screening | 1/11/1994 | Western land | 6 | 5 groundwater samples<br>8 soil samples<br>4 composite samples |
| Report to St George Partnership Banking Ltd, Environmental Site Screening | 1/11/1994 | Eastern carpark | 3 | 1 groundwater sample<br>6 soil samples<br>1 composite sample |
| Report to All Star Real Estate on Further Contamination Investigation for Cronulla Sutherland Leagues Club | 15/2/1995 | Western land | 34 | 30 soil samples<br>4 groundwater samples |
| Report to Cronulla Sharks Rugby Leagues Club on Environmental Site Screening for Shark Park Redevelopment | 29/11/2000 | 4 western<br>4 eastern<br>2 central | 10 | 19 soil samples<br>8 composite samples |
| Report to Cronulla Sutherland Leagues Club on Further Environmental Site Assessment for Proposed Cronulla Leagues Club Rezoning | 10/2002 | 10 eastern<br>2 western | 12 | 24 soil samples |
| Report to Cronulla-Sutherland District Rugby League Football Club on Environmental Site Assessment for Proposed Upgrade Works at Toyota Park | 8/2006 | Southern section of western land | unknown | 70 soil samples<br>8 groundwater monitoring wells sampled |

The 1:25,000 Department of Land and Soil Conservation (1997) soil landscape map identifies the subject site as 'disturbed terrain', indicating the estuarine soils that were once part of the environment have been significantly altered or buried by waste materials. The site sits on approximately 1-4.5 m of fill, underlain by natural organic-rich estuarine soils, with bedrock (Hawkesbury sandstone) encountered from 12-26 m.

A shallow sandy alluvial aquifer exists in the region. The aquifer has moderate to high salinity levels (2,200 to 34,000 µS/cm) due to salt water intrusion from Woolooware Bay (EIS 2011).

Results of geotechnical investigations by EIS suggest that the site is contaminated as a result of past in-fill. Contaminants recorded at various locations throughout the subject site include arsenic, asbestos, lead, and benzo(a)pyrene. Mercury and elevated concentrations of ammonia have been recorded in groundwater within the site. The site is known to be producing methane gas caused by decomposing organic matter.

It is likely that potential acid sulfate soils (ASS) exist underneath the fill, as they are present throughout the region and are associated with estuarine conditions. ASSs oxygenate and produce sulfuric acid when exposed to the air. This can adversely impact ecosystems (e.g. cause fish kills and contaminate foraging habitats).

The proposed development will not allow excavation (even at the edge of the mangroves) to minimise the risk of ASS and other contaminants being released into the environment. A detailed soil and water management plan will need to be prepared prior to on-ground works.

## 2.4 SURFACE WATER

There is an open, tidal channel to the west of the Toyota Stadium, which is defined as a second order creek by the Office of Water. The tidal channel is 5 to 6 m wide and approximately 1.5 m deep from top of bank. It drains an urban catchment of approximately 253 ha (i.e. about 25 times the area of the subject site). The majority of runoff from the 253 ha catchment is discharged into Woolooware golf course, which acts as a temporary flood storage, before entering the channel.

The existing drainage regime within the subject site is described by AT&L in a preliminary stormwater report prepared for the concept plan. The site itself can be divided into four main hydrological parts:

- Toyota Stadium drains to the tidal channel
- The club's building which drains towards Captain Cook Drive's drainage system, which eventually discharges to the tidal channel
- The carpark adjacent to the club's building. Approximately one third of the bitumen covered carpark area drains towards Captain Cook Drive, one third discharges to Woolooware Bay as a diffuse outflow through grassed buffer located to the east of the site and one third drains through a 150 mm diameter pipe directly to the Bay as concentrated flow
- The training field and carpark. Approximately half of the training field drains towards the carpark which drains towards the tidal channel. The other half discharges to Woolooware Bay as sheet flow

Natural coastal wetlands (such as those in Woolooware Bay) are characterised by a hydrological regime consisting of high concentrated flows during flood events and diffuse flow from surface and groundwater during non-flood periods. Hydrological and sedimentation regimes are often the main physical drivers in coastal wetlands such as mangroves (Lee 2006). Within the water column, changes

in hydrologic conditions can alter or modify chemical and physical properties such as nutrient and toxicant availability pH, salinity and dissolved oxygen concentrations, which have consequences for aquatic biota (Sriyaraj & Shutes 2001).

Wetlands are known to have properties for removal of pollutants, acting as filter in the water-land interface. For effective removal of pollutants, sheet rather than highly focused flows must occur and advance at a slow velocity and shallow enough depth to allow interaction with the sediment–water interface (Prior & Johnes 2002). Thus any changes to hydrological regime in the wetlands may impact not only on biota but also on wetland functioning.

## 2.5 NOISE

The noise assessment for the concept plan was completed by Acoustic Logic in June 2011.

*Existing noise*

Existing background levels of background noise are indicated in **Table 3**. These levels were recorded on the southern and eastern boundaries of the western land.

**Table 3: Background noise levels (Acoustic Logic 2011)**

| LOCATION | TIME PERIOD | METHOD | MEASURED NOISE LEVEL* |
|---|---|---|---|
| Western site | 7 am – 6 pm | Ambient | 44 |
| Western site | 6 pm -10 pm | Ambient | 42 |
| Western site | 10 pm - 7 am | Ambient | 34 |
| Captain Cook Drive - western site | Peak afternoon (3.30 pm to 6 pm) | Attended | 67 |
| Captain Cook Drive - western site | Peak afternoon (3.30 pm to 6 pm) | Attended | 64 |
| Stadium noise - western site | Night game (7.45 pm to 8.30 pm) | Attended | 65 |

*DB(A) LEQ (15 min)

The site is currently subjected to noise from aircraft, traffic and sports events. Examples of types of existing sources of noise in the study area are approximated below. Acoustic Logic recorded noise levels associated with these events of between 50 - 64 dB(A) at the subject site and at Towra Point.

**Table 4: Examples of existing noise levels (Acoustic Logic 2011)**

| LOCATION | NOISE SOURCES | APPROX. NOISE LEVEL |
|---|---|---|
| Towra Point | Boats | 65-70 dB(A) $L_{10}$ |
| | Traffic Noise | 50-55 dB(A) $L_{10}$ |
| | Sporting Events | 55-60 dB(A) $L_1$ |
| | Aircraft Noise | 65-70 dB(A) $L_{10}$ |
| Adjacent mangroves | Boats | 65-70 dB(A) $L_{10}$ |
| | Traffic Noise | 55-60 dB(A) $L_{10}$ |
| | Sporting Events | 65-70 dB(A) $L_1$ |
| | Aircraft Noise | 65-70 dB(A) $L_{10}$ |

*Predicted noise levels*

The expected noise levels from a number of 'worst case' proposed construction activities to be experienced in the study area are tabulated below. All noise levels detailed in the table are presented as the typical maximum dB(A) $L_{10}$ noise levels associated with the nominated equipment and will not be accumulative. Noise levels will only result during periods when the equipment is in operation. All calculated noise levels presented assume no screening and will reduce by 5-8 dB(A) if screening from other structures occurs.

**Table 5: Construction noise levels at various locations (maximum levels)**

| Equipment Type | Sound Power Level (SWL) | Wetland directly adjacent to the site | 20m from the site | 40m from the site | 60m from the site | Towra Point 500 m from the site | Discussion |
|---|---|---|---|---|---|---|---|
| Hydraulic Hammers* | 115 | 87 dB(A) | 81 dB(A) | 75 dB(A) | 71 dB(A) | 50 dB(A) | Intermittent noise level as equipment cannot run continuously |
| Concrete Saw Cutting* | 114 | 86 dB(A) | 80 dB(A) | 74 dB(A) | 70 dB(A) | 49 dB(A) | Only when in operation |
| Excavator (without hammer) | 98 | 70 dB(A) | 64 dB(A) | 58 dB(A) | 54 dB(A) | 33 dB(A) | Detailed noise levels based on worst case levels (i.e. operating at boundary of the site with the wetlands) |
| Drill Piling equipment | 105 | 77 dB(A) | 71 dB(A) | 65 dB(A) | 61 dB(A) | 40 dB(A) | Detailed noise levels based on worst case levels (i.e. operating at boundary of the site with the wetlands) |

*Note: Operations will be limited as site is predominantly sand.

Future noise levels from the operation of the development (following the construction period) will be designed to comply with the DECCW noise level criteria:

- Day time noise objective - 53 dB(A) $L_{eq}$
- Evening noise objective - 45 dB(A) $L_{eq}$
- Night time noise objective - 40 dB(A) $L_{eq}$

This includes all building services noise including mechanical equipment, loading docks, car parking, etc.

Some additional noise from activities such as the cycle path and playground will result in noise levels of up to 65 dB(A) in the adjacent wetlands. These represent a level which is no greater than that currently experienced on the site associated with events (e.g. traffic, aircraft and sport). Noise associated with play areas and cycleways on the site will be inaudible at the Towra Point Reserve and Taren Point Shorebird Reserve.

## 2.6 ECOLOGY

The subject site has suffered significant disturbance associated with past vegetation clearing and land reclamation. As a result, there is very little remnant vegetation and habitat on the site, as described in more detail in **Section 5**. Mangroves growing in the north-south drainage channel are the most significant habitat on the subject site. Other vegetation includes exotic grass on the playing fields, planted trees along Captain Cook Drive, on the northern side of Toyota Stadium and the leagues club building, in the western carpark and along the western boundary. Planted trees are a mix of native and exotic species.

The wider study area has significant ecological value. The development site itself is situated adjacent to mangroves (primarily *Avicennia marina*) that are central to a corridor along the margins of Woolooware Bay. These mangroves form part of the Woolooware Bay mangrove community and link to Taren Point Shorebird Reserve, and Towra Point Nature Reserve and Aquatic Reserve. Mangroves within the tidal channel of the subject site connect the mangroves in Woolooware Bay to patches of estuarine vegetation communities on the southern side of Captain Cook Drive.

Weeds have invaded the landward edges of mangroves and terrestrial vegetation throughout much of the study area. Further loss of habitat value has resulted from rubbish dumping, untreated stormwater and possibly leachate from the old landfill.

# 3 Legislative context

## 3.1 INTERNATIONAL AGREEMENTS

*International Migratory Bird Agreements*

Towra Point Nature Reserve is subject to the following international migratory bird agreements:

- Japan - Australia Migratory Bird Agreement (JAMBA)
- China - Australia Migratory Bird Agreement (CAMBA)
- Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA)

The JAMBA and CAMBA agreements list terrestrial, water and shorebird species which migrate between Australia and other countries. In both cases, the majority of listed species are shorebirds. Both agreements require the parties to protect migratory birds by:

- Limiting the circumstances under which migratory birds are taken or traded
- Protecting and conserving important habitats
- Exchanging information
- Building cooperative relationships

The JAMBA agreement also includes provisions for cooperation on the conservation of threatened birds.

Australian government and non-government representatives meet every two years with Japanese and Chinese counterparts to review progress in implementing the agreements and to explore new initiatives to conserve migratory birds (DSEWPAC 2011).

In April 2002, Australia and the Republic of Korea agreed to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA. The ROKAMBA formalises Australia's relationship with the Republic of Korea in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (DSEWPAC 2011).

Any actions that have the potential to impact upon these agreements are formally addressed under the Commonwealth legislation (see below).

## 3.2 COMMONWEALTH LEGISLATION

*Environment Protection and Biodiversity Conservation Act 1999*

The primary objective of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to 'provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance.'

Environmental approvals under the EPBC Act are required for an 'action' (i.e. a project, development, undertaking, activity or series of activities) that is likely to have a significant impact on the following.

- Matters of National Environmental Significance (known as 'NES matters') including:
    - World Heritage Areas

  - National Heritage Places
  - Ramsar wetlands of international importance
  - Nationally listed threatened species and ecological communities
  - Listed migratory species
  - Nuclear actions
- Commonwealth marine areas and Commonwealth heritage places
- Actions taken on Commonwealth land that are likely to have a significant impact on the environment
- Actions that are likely to have a significant impact on the environment of Commonwealth land, even if the action is taken outside Commonwealth land
- Any action taken by a Commonwealth agency that is likely to have a significant impact on the environment

**This report does not consider EPBC Act requirements or NES matters.**

A separate assessment process has been conducted by Bluestone Capital Ventures No.1 with regard to the EPBC Act. Following consideration of information submitted by Bluestone Capital Ventures No.1, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities has advised that the proposed redevelopment of the Sharks Leagues Club site is not a controlled action and does not require further assessment and approval under the EPBC Act (refer to the letter in **Appendix B**).

## 3.3 NEW SOUTH WALES LEGISLATION

*Environmental Planning and Assessment Act 1979*

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for NSW. It provides a framework for land use control and assessment, determination and management of development. Part 3A of the EP&A Act facilitates major project and infrastructure delivery of development which is of significance to the State.

A preliminary environmental assessment (PEA) was prepared and submitted to the NSW Department of Planning and Infrastructure in December 2010 for the initial submission under Part 3A. Following a review of the PEA, and after consultation with other relevant government agencies, the Department of Planning issued Director-General's requirements (DGRs) for the project. The DGRs that are relevant to flora and fauna are listed in **Table 6,** with a reference to where they have been addressed in this report using the information currently available.

**Table 6: Director-General's requirements**

| DGRs | CROSS-REFERENCE |
|---|---|
| *Address the impact on flora and fauna, including threatened species, populations and endangered ecological communities and their habitats and steps taken to mitigate any identified impacts to protect the environment, both marine and land in accordance with 'DECC Threatened species assessment guideline 2007'. Including a detailed survey of migratory bird habitat and determine whether and how they are using the site and adjoining areas, and assess any potential impacts or threats to the population.* | Potential impacts on flora and fauna are identified in **Section 6**.<br><br>In accordance with *DECC's Threatened Species Assessment Guidelines 2007*, tests of significance have been conducted for threatened species and communities known or likely to occur within the study area (**Appendices D** and **E**).<br><br>Due to time constraints, a detailed ecological survey of migratory birds was not completed. However, in a letter to the Department of Planning (dated 25/3/11), DECC advised that recent (less than five years old) surveys and assessment may be used instead of detailed ecological survey. This report is primarily based on a desktop assessment of previous surveys. Further detail of the methodology is given in **Section 4.** |
| *Provide a description of mitigation and* management *options that will be used to prevent, control abate or minimise identified impacts on Towra Point Aquatic Reserve. Including an assessment of the effectiveness and reliability of the measures and residue impacts after measures are implemented* | This report has been prepared to accompany the concept plan. It includes mitigation and management principles (**Section 6**) that should be incorporated in future detailed plans to manage construction activities and ongoing maintenance. |
| *Provide a detailed biodiversity assessment,* including *assessment of impacts on threatened biodiversity native vegetation and habitat.* | **Section 6** outlines threatened species and communities within the study area, and assesses potential impacts. |
| *Address the protection and enhancement of riparian land along the southern shore of Woolooware Bay and watercourse on the site and asses and provide details of all watercourses and riparian land on the site. Including assessing potential impacts, areas of disturbance and safeguard measures to mitigate impacts, contingency plans for remediation and rehabilitation of riparian areas in the event of potential adverse impacts and long term management of riparian lands* | As described in **Section 1.2.4**, the concept plan (**Appendix A**) allows for areas of native vegetation to be established between the development and mangroves. Potential impacts and safeguards are discussed in **Section 6**. |
| *Demonstrate compliance with the NSW Office of Water's guideline for controlled activities and outline the provision of a 40 m wide core riparian zone.* | Refer to the merit requirements in the *2008 WMA Guidelines for Controlled Activities (Riparian Corridors*) – under *Water Management Act* below and in **Table 7**. |

*Threatened Species Conservation Act 1995*

The *Threatened Species Conservation Act 1995* (TSC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act is integrated with the NSW EP&A Act and requires consideration of whether a major infrastructure project (Part 3A of the EP&A Act), a development (Part 4 of the EP&A Act) or an activity (Part 5 of the *EP&A Act*) is likely to significantly affect threatened species, populations and ecological communities or their habitat.

Threatened species and endangered ecological communities (EECs) that need to be assessed under this legislation and in accordance with the '*DECC threatened species assessment guideline 2007'* have been listed in **Appendix D** of this report. Tests of significance for species and ecological communities likely to be found in the vicinity of the subject site are provided in **Appendix E**.

Key threatening processes listed under the TSC Act that may be relevant to this project include:

- Alteration to the natural flow regime of rivers and streams and their floodplains and wetlands
- Clearing of native vegetation
- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments
    - Entanglement and ingestion of marine debris is likely to impact specific estuarine species associated with the site. This process can cause injury, decreasing the fitness and ability of species to reproduce, catch prey and avoid predation
    - This following species are recognised as likely to be impacted by this threatening process - little tern (*Sterna albifrons*), hooded plover (*Thinornis rubricollis*), greater sand plover (*Charadrius leschenaultii*), lesser sand plover (*Charadrius mongolus*), sooty oystercatcher (*Haematopus fuliginosus*), pied oystercatcher (*Haematopus longirostris*) and the osprey (*Pandion haliaetus*)
- Competition and grazing by feral European rabbit (*Oryctolagus cuniculus)*
- Invasion of native plant communities by the African olive (*Olea africana*)
- Invasion, establishment and spread of *Lantana camara*
- Invasion of native plant communities by *Chrysanthemopides monilifer* (bitou bush / boneseed)
- Predation by European red fox (*Vulpes vulpes*)
- Predation by the feral cat (*Felis catus*)

*Fisheries Management Act 1994*

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. The FM Act defines 'fish' as any marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history, excluding whales, mammals, reptiles, birds, amphibians or species specifically excluded. No threatened fish species or endangered populations listed under the FM Act are known to occur within the study area.

Division 4 of Part 7 of the FM Act makes provisions for the protection of mangroves and certain other marine vegetation. Under the FM Act, it is illegal to harm marine vegetation except under the authority of a permit issued by the Minister.

The FM Act is supported by the policy and guidelines for aquatic habitat management and fish conservation (1999).

*Water Management Act 2000*

Controlled activities carried out in, on or under waterfront land are regulated by the *Water Management Act 2000* (WMA). The NSW Office of Water is required to assess the impact of a controlled activity to ensure that minimal harm will be done to any waterfront land. The *2008 WMA Guidelines for Controlled Activities (Riparian Corridors*) suggest that:

- The prescribed core riparian zone (CRZ) for 3rd order or greater streams is 20-40 m, plus a vegetated buffer (VB) of 10 m
- The CRZ for 2nd order streams is 20m CRZ, plus a VB of 10m

The guidelines state that a merit assessment based on riparian functionality and long-term land use is allowed to determine CRZ widths of 3rd order streams and all VB widths.

The proposed landscaped zones that represent the CRZs and VBs within the subject site are illustrated in the concept plan in **Appendix A**. Features of the landscape zones are tabulated below.

**Table 7: Riparian landscape zone**

| LOCATION | ORDER | WIDTH* | FEATURES |
|---|---|---|---|
| Channel (western side only) | 2nd order | 20 m | Bioretention swale<br>Revegetation<br>Stormwater pipes<br>Sealed path<br>Bridges (two new, one existing) |
| Woolooware Bay – eastern land | 3rd order | 30 m | Boardwalk access to mangroves (replace existing)<br>Path/cycleway<br>Revegetation<br>Seawall<br>Courtyard and leisure breakout (part)<br>Electricity transmission tower (existing) |
| Woolooware Bay – Toyota Stadium | 3rd order | | Path/cycleway<br>Revegetation<br>Seawall<br>Terrace retaining walls (stabilise existing hill) |
| Woolooware Bay – western land | 3rd order | 30 m | Path/cycleway<br>Revegetation<br>Picnic/BBQ facilities (part)<br>Turfed area<br>Boardwalks and platforms |

*Width of landscaped zone from top of bank

*Noxious Weeds Act 1993*

The *Noxious Weeds Act 1993* (NW Act) defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The Act sets up categorisation and control actions for the various noxious weeds according to their potential to cause harm to our local environment.

The objectives of the NW Act include:

- To identify noxious weeds in respect of which particular control measures need to be taken
- To specify those control measures
- To specify the duties of public and private landholders as to the control of those noxious weeds
- To provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities

Under this Act, noxious weeds have been identified for local government areas and assigned control categories (e.g. 1, 2, 3, 4 and 5). Part 3 of the NW Act provides that occupiers of land (this includes owners of land) have responsibility for controlling noxious weeds on the land they occupy. KBR (2007) identified eight noxious weeds on the Cronulla Sharks site, which are listed in **Section 5.2**.

*State Environmental Planning Policy 44 (Koala Habitat)*

State Environmental Planning Policy 44 (Koala Habitat) (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

SEPP 44 applies to the Sutherland Shire LGA. However, the lack of suitable vegetation in the study area means that a SEPP 44 assessment is not required.

*State Environmental Planning Policy 19 (Bushland in Urban Areas)*

SEPP 19 aims to protect and preserve bushland within urban areas such as Sutherland Shire LGA because of its value to the community as part of the natural heritage, its aesthetic value, and its value as a recreational, educational and scientific resource. The policy is designed to protect bushland in public open space zones and reservations.

The lack of bushland within the foreshore area that is zoned for public open space indicates that a SEPP 19 assessment is not required.

*State Environmental Planning Policy 55 (Remediation of Land)*

The object SEPP 55 is to provide for a Statewide planning approach to the remediation of contaminated land.

As outlined in **Section 2**, the site is known to have contaminated fill. However, one of the main principles of the development is that there will be no excavation and no remediation of the site. Therefore, no further consideration of SEPP 55 is required.

*State Environmental Planning Policy 62 (Sustainable Aquaculture)*

SEPP 62 relates to the current proposal because oyster leases are located within Woolooware Bay. Under Part 3A of SEPP 62, the consent authority must consider if the proposed development would have an adverse effect on oyster aquaculture development or a priority oyster aquaculture area. Much of Woolooware Bay has been identified in the *NSW Oyster Industry Sustainable Aquaculture Strategy* as a priority oyster aquaculture area.

*Greater Metropolitan Regional Environmental Plan No.2 (Georges River Catchment)*

REP No. 2 aims to protect the water quality of the Georges River and its tributaries and the environmental quality of the whole catchment. The objectives are to be achieved through coordinated land use planning and development control. Key objectives are:

- To preserve and protect and to encourage the restoration or rehabilitation of regionally significant sensitive natural environments such as wetlands (including mangroves, saltmarsh and seagrass areas), bushland and open space corridors within the Catchment, by identifying environmentally sensitive areas and providing for appropriate land use planning and development controls,
- To preserve, enhance and protect the freshwater and estuarine ecosystems within the Catchment by providing appropriate development
- To conserve, manage and improve the aquatic environment within the Catchment which is a significant resource base for the aquaculture industry, by providing controls aimed at reducing pollution entering the Catchment's watercourses

*Sutherland Shire Local Environmental Plans*

The subject site is affected by two local environmental plans as shown in **Figure 3**. The western and central land is mainly zoned Private Recreation (Zone 15) under *Sutherland Local Environmental Plan 2006* (SLEP 2006), with the foreshore zoned for Public Open Space – Bushland (Zone 14). The eastern section of the site, including the Sharks Leagues club and car parking area is zoned 6(b) Private Recreation under the *Sutherland Local Environmental Plan 2000* (SLEP 2000), with the foreshore area zoned 6(a) Public Recreation.

Rezoning will be required to permit redevelopment of the site as a mixed use neighbourhood retail centre and residential estate. This will applied for under Part 3A of the EP&A Act.


**Figure 3: Land use zones (Source: SLEP 2006)**

# 4 Methodology

In summary, the methodology for this assessment involved a review of previous studies and data, field investigation of the subject site, consideration of impacts that may result from the proposed development, and identification of mitigation measures.

**Table 8** identifies the main staff responsible for this assessment. All staff are employees of Eco Logical Australia Pty Ltd (ELA). Additional ELA staff were consulted during preparation of this report.

**Table 8: Staff and qualifications**

| STAFF MEMBER | QUALIFICATIONS |
|---|---|
| Beth Medway | Master of Environmental Engineering Science (UNSW)<br>Master of Environmental Studies (UNSW)<br>Bachelor of Science (Applied Physical Geography) (1st Class Hons) (UNSW) |
| Ian Dixon | Master of Tropical Environmental Management: The Relationship Between Terrestrial, Aquatic and Riparian Attributes<br>Graduate Diploma of Tropical Environmental Management<br>Bachelor of Landscape Architecture |
| Kathryn Korbel | Bachelor Environmental Science (Hons) University of Wollongong |

## 4.1 DATA AND LITERATURE REVIEW

Literature, GIS data and database records pertaining to the ecology of the study area and surrounding locations were reviewed to provide background information. The literature and data review considered:

- DECC wildlife atlas database (10 km radius)
- Flora and fauna assessments of the Cronulla Sharks League Club site (KBR 2007, Gunninah 2000/2002, AMBS 2006)
- Mosquito risk assessment (Webb & Russell 2005)
- Natural vegetation of Sydney (Benson & Howell 1994)
- Ecological assessment of health club development (ELA 2005)
- Ecological assessment of Taren Point Shorebird Reserve (ELA 2007)
- Various scientific studies, policies and plans that relate more generally to impacts on coastal wetlands and related biota

## 4.2 FIELD INVESTIGATION

The field investigation focussed on identifying flora species and vegetation communities within the subject site. Incidental fauna were recorded. Fish and other aquatic species were not surveyed as part of this study.

Fieldwork was undertaken on the 20th of June 2011 by Ian Dixon and Kathryn Korbel. The site inspection involved three person hours and all vegetation within the subject site was examined. At the time of the study the temperature was 10ºC, wind speed negligible, with no rain recorded in the previous 24 hours.

Generally, field surveys should be completed over a range of climatic conditions and during a number of seasons to optimise the potential for species to be recorded at a site. Fieldwork for the current, as well as previous studies, were conducted in winter, a time when the majority of migratory shorebird species are breeding in the northern hemisphere, and the detection of frogs and reptiles would also be limited.

## 4.3 LIKELIHOOD OF OCCURRENCE

An assessment of the 'likelihood of occurrence' was made for threatened ecological communities, populations and species that are listed under the NSW *Threatened Species Conservation Act 1995* and identified from a search of a 10 km radius from the centre of the subject site. This assessment included database and other records (as outlined above), presence or absence of suitable habitat, features of the subject site, results of the field survey and professional judgement.

A summary of the results of this data audit along with a 'likelihood of occurrence' ranking using the following terminology can be found in **Appendix D**.

- "Known" = the species was or has been observed in the study area and may be affected by indirect impacts from the development
- "Likely" = a medium to high probability that a species uses the study area and may be affected by indirect impacts from the development
- "Potential" = suitable habitat for a species occurs in the study area, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- "Unlikely" = a very low to low probability that a species uses the study area
- "No" = habitat in the study area is unsuitable for the species

## 4.4 ASSESSING IMPACTS

In accordance with DECC's 2007 guidelines, tests of significance were performed for threatened species and communities that were identified as known, likely or having potential to occur in the vicinity of the subject site. The tests are provided in **Appendix E**. Further explanation of the impacts and recommended mitigation measures is given in **Section 6**.

# 5 Results

The ground surface and ecology of the subject site have been determined by past landfill activities, development and management practices. With the exception of mangroves growing in the channel and small patches of native vegetation on the margins, most vegetation on the subject site appears to be either planted or invasive weeds. This conclusion is supported by a comparison of historical aerial photographs (**Appendix C**) to current conditions.

**Figure 4** shows the distribution of vegetation on the subject site and immediate surrounds. These areas are the focus of this assessment.

Weeds and exotic shrubs have proliferated in areas where the landfill transitions to 'natural' ground level (typically 0.5 to 1.5 m lower) along the northern perimeter of the subject site. Healthy mangrove communities are present beyond the transition zone, where the substrate and ground levels are relatively undisturbed.

**Photo**: Transition zone from level of eastern carpark (yellow line) to 'natural' ground surface of wetland

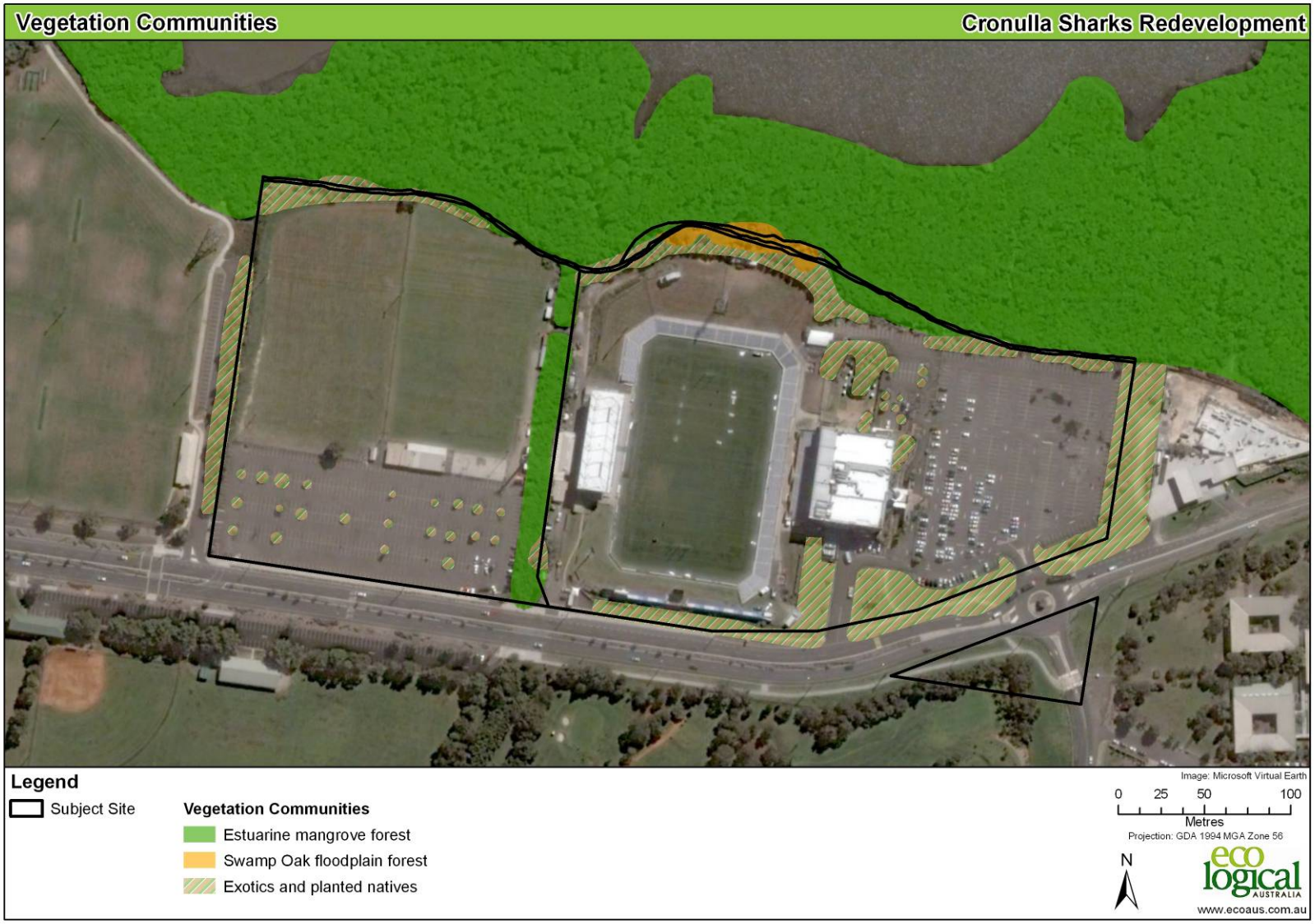


**Figure 4: Vegetation communities within the subject site and immediate surrounds**

## 5.1 ENDANGERED ECOLOGICAL COMMUNITIES

*Swamp oak floodplain forest*

A patch of swamp oak floodplain forest, which is listed as an endangered ecological community (EEC) under the TSC Act, is present on the hill to the north of Toyota Stadium (**Figure 4**). The community is typically found in close proximity to rivers and estuaries where soils have a saline influence, such as on the fringe of Woolooware Bay. The patch on the subject site comprises less than ten swamp oak (*Casuarina glauca*) trees. There are a few individual trees elsewhere across the site (e.g. along the tidal channel).

The Scientific Committee's final determination of the swamp oak floodplain forest does not delineate between higher and lower quality remnants of this community. It specifically notes that partial clearing and disturbance, in some instances, may have reduced this community to scattered trees and this disturbed type is still considered part of the EEC. Relatively few examples of this community would be unaffected by weedy taxa, including noxious species, such as those listed in a variety of key threatening processes (e.g. lantana, introduced perennial grasses and exotic vines / creepers).

From the historical aerial photos it is likely that this community, together with coastal saltmarsh and mangrove forest, would have grown in suitable conditions across the subject site prior to landfilling. There is no coastal saltmarsh remaining within the subject site, although patches are found in nearby areas (e.g. adjacent Solander Oval to the west).

There is an opportunity to rehabilitate or recreate a succession from the existing mangrove forest to swamp oak floodplain forest, and possibly including coastal saltmarsh in the proposed landscaped areas of the redevelopment.

*Taren Point shorebird community*

The Taren Point shorebird endangered ecological community (TPS EEC), which is listed under the TSC Act, is restricted to the intertidal sandflats between Taren Point and Shelley Point, including the Taren Point Shorebird Reserve. The location of the reserve is indicated in **Figure 2**. The EEC has an assemblage of twenty shorebird species (listed in **Appendix E**) which includes some species (e.g. the eastern curlew *Numenius madagascariensis* and bar tailed godwit *Limosa lapponica*) that have been recorded in mangroves adjacent to the subject site. Mangroves are an important roosting habitat for some species within this EEC.

DECC has identified the following threats to the TPS EEC:

- Loss of feeding and roosting habitat
- Fragmentation or isolation of sites within feeding areas resulting in decreasing abundance
- Human disturbance at roost and feeding sites
- Disturbance by dogs at roost and feeding sites
- Pollution

## 5.2 FLORA

158 plant species have been recorded on or immediately adjacent to the subject site, comprising 105 introduced species, 41 native (planted) species and twelve naturally occurring native species (**Appendix F**).

Two flora species that are listed under the *Threatened Species Conservation Act 1995* have been recorded on the subject site:

- Magenta lillypilly (*Syzygium paniculatum)*
- Wallangarra white gum (*Eucalyptus scoparia*)

However, these are not native to the region and have been planted in landscaped areas adjacent the leagues club building.

An additional six threatened flora species have been recorded within a 10 km radius of the site. None of these species were observed on or near the site or are likely to be found because of lack of suitable habitat.

As depicted in **Figure 4**, there are three vegetation communities within the subject site.

- Estuarine mangrove forest
- Swamp oak floodplain forest
- Exotics and planted natives

*Estuarine mangrove forest*

An estuarine mangrove forest is the predominant native vegetation community on the subject site (in the channel) and adjacent to the northern perimeter in Woolooware Bay (**Figure 4**). This community comprises a monoculture of grey mangrove (*Avicennia marina*) which grows between the low and high tide mark. The understorey and groundcover of the community consists of juveniles and pneumatophores, both growing in the estuarine sediment. The mangroves provide important habitat for a variety of terrestrial and aquatic fauna species.

**Photo**: Mangrove forest adjacent the western land of the subject site; note weedy margin

*Swamp oak floodplain forest*

This EEC is discussed in **Section 5.1**.

*Exotics and planted natives*

There are several areas on the site that have been landscaped with exotic/introduced species and native species (**Figure 4**), and many of these areas have become weed infested. Weeds and planted species recorded at the subject site and immediate surrounds are listed in **Appendix F.** Poor management practices have contributed to weed infestation, including untreated leachate and stormwater inputs, as well as dumped rubbish, lawn clippings and building materials.

Several noxious weeds that are listed in the Sutherland control area have been recorded on site (**Table 9)**. Noxious species are categorised as N4 and N3 weeds under the *Noxious Weeds Act* 1993. N3 category weeds must be fully and continuously suppressed and destroyed. The growth and spread of N4 weeds must be controlled in accordance with a management plan.

**Table 9: Noxious weeds recorded on the subject site**

| COMMON NAME | SCIENTIFIC NAME | CATEGORY |
|---|---|---|
| Bitou bush | *Chrysanthemoides monilifera* | N4 |
| Castor oil plant | *Ricinus communis* | N4 |
| Green cestrum | *Cestrum parqui* | N3 |
| Lantana | *Lantana camara* | N4 |
| Pampas grass | *Cortaderia* spp. | N3 |
| Pellitory | *Parletaria judacia* | N4 |
| African olive | *Olea europaea subsp. africana* | N4 |
| Photinia | *Photinia glabra* | N4 |

Source: NSW Primary Industries website[2]

## 5.3 HABITAT AND CORRIDORS

Habitat on the site includes managed landscaped areas, unmanaged areas of weeds and exotics, patches of native species (e.g. *Casuarina glauca*) and the mangrove forest in the creek. Overall, the subject site itself has little habitat value. However, the mangroves in the creek and adjacent areas offer important habitat and act as wildlife corridors.

Mangrove forests and associated tidal mudflats provide potential nesting, foraging and refuge for a number of estuarine and coastal species including birds, bats and aquatic fauna (e.g. fish, eels and crustaceans). The mangroves also provide a wildlife corridor across the northern boundary of the site, connecting the Taren Point shorebird community habitats to Towra Point Nature Reserve and Aquatic Reserve. The mangroves in the channel provide a corridor between Woolooware Bay and patches of estuarine vegetation on the southern side of Captain Cook Drive. Tidal waters are uninhibited in the region, providing breeding grounds and refuge for fish and other aquatic species.

[2] http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed viewed 13 July 2011

Terrestrial wildlife corridors are limited to weed-infested vegetation on the northern margins of the subject site. This habitat is poor, but may provide some opportunities for small birds. Trees that have been planted across the subject site would provide some habitat for common generalist bird species and opportunistic mammals such as possums. It is unlikely that threatened species would utilise the terrestrial habitat found on the subject site.

Waste materials provide habitat and food sources for native mammals such as possums, with introduced species such as foxes, rabbits and rats likely to scavenge and utilise landscaped areas around the existing clubhouse.

## 5.4 FAUNA

A total of 41 fauna species have been identified on the subject site or in the adjacent mangroves (**Appendix G**). This includes five mammal species, 34 bird species and one reptile species, as well as the mosquito (*Ochlerotatus vigilax).*

As indicated in **Appendix G**, there are fourteen threatened fauna species listed under the TSC Act that have been recorded in the broader study area that are considered likely or potential users of habitat found in or near the subject site. Only one of these species, the grey-headed flying-fox (*Pteropus poliocephalus*), has been recorded on the subject site or adjacent mangroves (KBR 2007). The grey-headed flying-fox is listed as vulnerable under TSC Act. There is a communal roost (colony) of this species on the Kurnell peninsula. There are no communal roosts of flying foxes located either on or adjacent to the site. This species would probably utilise the mangrove habitat as a foraging site.

The mangrove community on and adjacent to the site also provides habitat for microbat species. One microbat, the little forest bat (*Vespadelus vulturnus*), has been recorded in these mangroves (KBR 2007). This and other bat species are likely to utilise hollows for shelter and forage amongst mangroves. Other species such as *Myotis* and *Mormopterus norfolkensis* are known to roost and actively forage in and around these areas. There are ample hollows of a suitable size for microbats in the mature mangrove forest.

# 6 Impact assessment & mitigation

This section of the report outlines the anticipated impacts from the proposed development on the ecology of the site and surrounding areas based on the concept design and related studies. Results of the assessment and measures that could be used to avoid or minimise potential impacts are identified in **Table 10** and **Appendix E**, and summarised as follows:

- Most of the existing terrestrial vegetation will be cleared from the subject site, but on balance there will be an improvement in the extent and condition of vegetation and habitat within the site once revegetation is established
- Landscaping on the northern margins of the subject site will incorporate local provenance species that are consistent with estuarine vegetation communities (i.e. mangrove – coastal saltmarsh – swamp oak floodplain forest)
- The risk of ecosystems being further impacted by contaminants and acid sulfate soils will be minimised because there will be no excavation of fill, including along the northern margins where the fill joins the natural ground surface of the mangroves. The boundary of the eastern land and Toyota Stadium will be stabilised with a seawall. The northern edge of the western land will be revegetated
- The risk of trampling will be minimised because public access to the mangroves will be restricted by low fences, boardwalks or revegetation, and supported by signage and education
- Mangroves in the tidal channel are likely to be impacted by shadow and an altered hydrologic/hydraulic regime which may affect flora growth and dispersal. Construction of stormwater infrastructure and the two pedestrian bridges may require removal of some mangroves in the channel
- As outlined in **Appendix E,** fauna species that use mangrove habitat in Woolooware Bay may be affected by construction noise up to 60 m from the subject site. These mangroves and associated fauna may also be affected by changed stormwater conditions (to be determined by further investigation including water quality and flood modelling). Impacts to mangroves will not significantly affect threatened species or communities because alternative habitat is available nearby

Appropriate design and management can be used to address potential impacts. For example:

- Sources of artificial light could be designed so that light is directed away from mangroves
- Stormwater could be treated so that water quality in Woolooware Bay is not adversely affected
- Construction noise can be mitigated by application of DECCW noise level criteria

The assessment found that the proposed development is unlikely to have a significant effect on threatened species, populations, ecological communities or their habitats, and accordingly a Species Impact Statement is not required for the proposal. Management plans need to be prepared for activities related to noise and vibration, soils, vegetation/weed control, water and waste management.

**Table 10: Potential impacts and mitigation measures**

| ISSUE | IMPACT | MITIGATION |
|---|---|---|
| Vegetation / habitat & weed management | Vegetation to be cleared includes:<br>• Planted trees in the carpark on the western land<br>• Some trees in the proposed retail courtyard<br>• Weed infested vegetation on the northern edge of the entire subject site. This includes a small pocket of swamp oak floodplain forest (EEC) on the hill to the north of the stadium, which may be cleared when the hill is lowered by 1 m (subject to detailed design)<br><br>The loss of vegetation will be offset by the creation of landscaped areas on the northern margin of the entire subject site and on the western side of the channel. The landscape plan (**Appendix A**) aims to replicate the succession of estuarine vegetation communities (mangroves – coastal saltmarsh – swamp oak floodplain forest) and use of local provenance species. Saltmarsh communities are especially sensitive to micro-changes in elevation, salinity, soil/water chemistry, photoperiod etc, and so will need careful design and adaptive management to ensure success<br><br>On balance, the proposed landscaping represents a significant improvement in the vegetation and fauna habitat of the subject site. It is noted that the landscape zone includes built structures such as the path/cycleway, boardwalks, playground and picnic facilities | Prepare and implement a vegetation management plan, including suitable design, species selection and propagation, replanting techniques, removal and disposal of weeds, ongoing monitoring and adaptive management<br><br>Revegetation to be done using local provenance species that are consistent with estuarine vegetation communities (i.e. mangrove – coastal saltmarsh – swamp oak floodplain forest)<br><br>Use clean fill for any levelling works associated with landscaping to reduce the risk of weed spread<br><br>Where possible, protect and retain existing native vegetation on the subject site |
| Significant biota | Based on the information available, possible impacts on fourteen threatened species and three endangered ecological communities have been assessment in accordance with the DECC's 2007 threatened species assessment guideline. Results are presented in **Appendix E**<br><br>The results suggest that there will be no significant impact to flora and fauna from the proposed development. Additional information is needed to determine the | Key threatening processes are listed in **Section 3.3**. The following measures are recommended to mitigate against these:<br>• Revegetation to offset loss of native vegetation on the subject site<br>• Gross pollutant traps and other waste management measures to minimise the incidence of rubbish and related risk of entanglement and ingestion of marine debris; as well |

| ISSUE | IMPACT | MITIGATION |
|---|---|---|
| | impact of changes to flow regimes. | as reduce habitat for pest animal species |
| Changed hydrological regime and water quality | It is recognised that the relationship between water, soils/fill and ecology at the subject site and surrounds is complex, dynamic and poorly understood due to lack of monitoring data.<br><br>Future sea level rise will contribute to changes at the site, irrespective of development. The proposed landscaped area and existing mangrove channel allow for predicted levels of sea level rise (ATL 2011).<br><br>Further investigation will be required to determine the likely impact of stormwater to the mangroves in the existing channel, the mangroves growing near the entrance of the channel to Woolooware Bay and areas upstream of the subject site that are affected by flows in the channel. Consideration will need to be given to expected volumes and quality of stormwater proposed to be discharged into the existing channel from the retail roof and residential area, as well as impacts associated with construction of additional stormwater infrastructure (e.g. pipes, tanks, traps). Impacts to the stability of the channel banks also need to be considered<br><br>There is unlikely to be a significant change to ecosystems within Woolooware Bay associated with rainfall onto the proposed landscaped areas to the north of the residential and retail areas. There will be some surface runoff to the bay but much of the rain is expected to infiltrate the soil and be taken up by vegetation or enter the groundwater.<br><br>The relationship between rainfall, leachate from the old tip and ecology (including groundwater dependent ecosystems) will be affected by the proportion of impermeable surfaces and vegetation, as well as degree of soil disturbance. Further detail of expected water quality and volumes associated with the proposed development is needed to determine if there is likely to be an improvement, | Detailed landscape design will need to ensure that ground levels are sufficient to cope with predicted sea level rise and that vegetation has space to shift landward as conditions change<br><br>Detailed design of stormwater management should aim to maintain or improve water quality and the hydrological/hydraulic regime to protect the mangroves in the channel and in Woolooware Bay<br><br>Soil and water management plan to be prepared for construction activities. The plan will provide details of how work will be achieved without the need for excavation<br><br>If sediments are inadvertently exposed, they must be classified as contaminated soils, work stopped until soils are treated appropriately under the *Contaminated Lands Act* and SEPP 55<br><br>Water sensitive urban design features to be incorporated in the development (e.g. rainwater tanks, gross pollutant traps, bioretention swales)<br><br>Clean fill should be used for any levelling, capping or landscaping works to minimise the risk of contaminating surface runoff or additional leaching of contaminants |

| ISSUE | IMPACT | MITIGATION |
|---|---|---|
| | decline or virtually no change to ecosystems in the bay.<br><br>The existing bitumen carpark on the eastern side caps the fill almost to the edge of the mangroves. Although most of the site will continue to be sealed once the retail centre is constructed, there may be leachate generated while the land is exposed during construction and when the landscape zone is created to the north of the site. | |
| Noise | Fauna (especially birds and bats) can be affected by noise and vibration. This is significant if noise continues and causes the fauna to be permanently displaced or if it disrupts lifecycle processes (e.g. birds tend to be more sensitive during breeding season). Some species will also refrain from utilising available foraging grounds when there is increased noise (SOPA 2007, ELA 2007).<br><br>Fauna inhabiting the subject site and surrounds are currently affected by noise associated with sporting events, aircraft and traffic etc. Future additional sources of noise include activities associated with construction, the retail loading dock, car parking, and use of the landscaped areas including playgrounds and cycleway. Further assessment would be required to determine the additional times (i.e. cumulative noise exposure) that would be experienced by fauna in the vicinity of the subject site.<br><br>Analysis by Acoustic Logic (2011) found that noise and vibration during construction will be greater than currently experienced up to 60 m northward from the subject site. This would probably result in temporary displacement of fauna from this area. Beyond 60 m, noise levels during construction will be similar to existing noise in the area associated with boats, traffic, sporting events or aircraft.<br><br>Noise levels following construction will be similar to levels currently experienced. Based on information provided by Acoustic Logic (2011), there will be no noise impacts on Towra Point Nature Reserve or Taren Point Shorebird Reserve | A noise and vibration management plan is required. The plan should identify how construction noise and ongoing noise associated with the development can be minimised. The plan should give consideration to materials used in the cycleway and playground to minimise ongoing noise generation. |

| ISSUE | IMPACT | MITIGATION |
|---|---|---|
| | associated with the proposed development. | |
| Light spill and shadowing | Flora and fauna are affected by patterns of light and shadow. For example:<br>• Altering the available light (e.g. shadowing), thus photosynthesis responses of plants, can result in changes to species composition within communities with light dependent species dying as a result of underexposure. Shadowing of wetlands has been documented to impact on the growth of grey mangroves (*Avicennia marina)* (Ball & Critchley 1982). However the impact on mangroves is not well established, and there is no known documentation of species death due to shadowing<br>• The roosting and nocturnal foraging habitats of some migratory waders are known to be disturbed by low levels of artificial light (SOPA 2007)<br>• Activities of nocturnal species such as bats may be impacted by increased levels of artificial light<br><br>There are no details available for the concept plan about the design of lighting for the proposed buildings and landscaped areas. Current levels of lightspill associated with stadium floodlights and the Leagues Club will continue.<br><br>Shadow diagrams have been prepared for the proposed development and are provided in **Appendix H**. The diagrams show that mangroves to the north of the site will not be affected by shadowing from proposed buildings. Mangroves in the channel will be shadowed from 3 pm onwards during summer and equinox, with winter shadowing occurring from 1 pm. Mangroves in the channel may already be subject to shadowing from the existing stadium, and the cumulative effects are unknown at this stage. | Design lighting so as to minimise light spill into and around mangroves and proposed revegetation areas |
| Trampling | The existing derelict boardwalk through the mangroves on the eastern side will be | Restrict access near landscaped areas and the mangroves to boardwalks |

| ISSUE | IMPACT | MITIGATION |
|---|---|---|
| | reconstructed at the same location<br><br>Pedestrian and bike traffic will be restricted to paths and boardwalks in sensitive areas, with low bollard/wire fencing used to control public access where necessary<br><br>There is no information at this stage regarding construction techniques, so it is not possible to determine the construction footprint for proposed paths and boardwalks | and paths<br><br>If necessary, construct low bollard/wire fences to restrict access to mangroves and proposed saltmarsh areas<br><br>Install signage to inform the community about the need to prevent trampling of native vegetation<br><br>Soil, water and vegetation management plans for construction activities need to include details about exclusion areas and techniques to avoid trampling sensitive areas, as well as requirements for restoration |
| Bird strike | Reflective windows associated with multistorey buildings have been documented to impact birds (Klem 1990a, b). Bird strikes are likely to be associated with the proposed development, particularly because the subject site is close to significant migratory bird habitat, and because the residential buildings will be up to fourteen storeys and will have a high proportion of glass windows | Community education to encourage residents to use window coverings (e.g. blinds and curtains), where possible, to reduce bird strike |
| Rubbish | As well as adversely affecting amenity, rubbish can attract pest species such as rats, encourage weeds and degrade habitat value. Entanglement or ingestion of human debris is recognised as a key threatening process for a number of species in the study area.<br><br>Significant levels of rubbish are present at the subject site, particularly at the northern margins and adjacent the stadium.<br><br>Although there will be additional potential sources of rubbish associated with the development, residents and retail users are likely to expect the area to be maintained to a high standard of cleanliness | Community education, provision of fauna-proof bins and regular rubbish removal programs will be required<br><br>Gross pollutant traps to be installed as part of the stormwater system will require regular maintenance |

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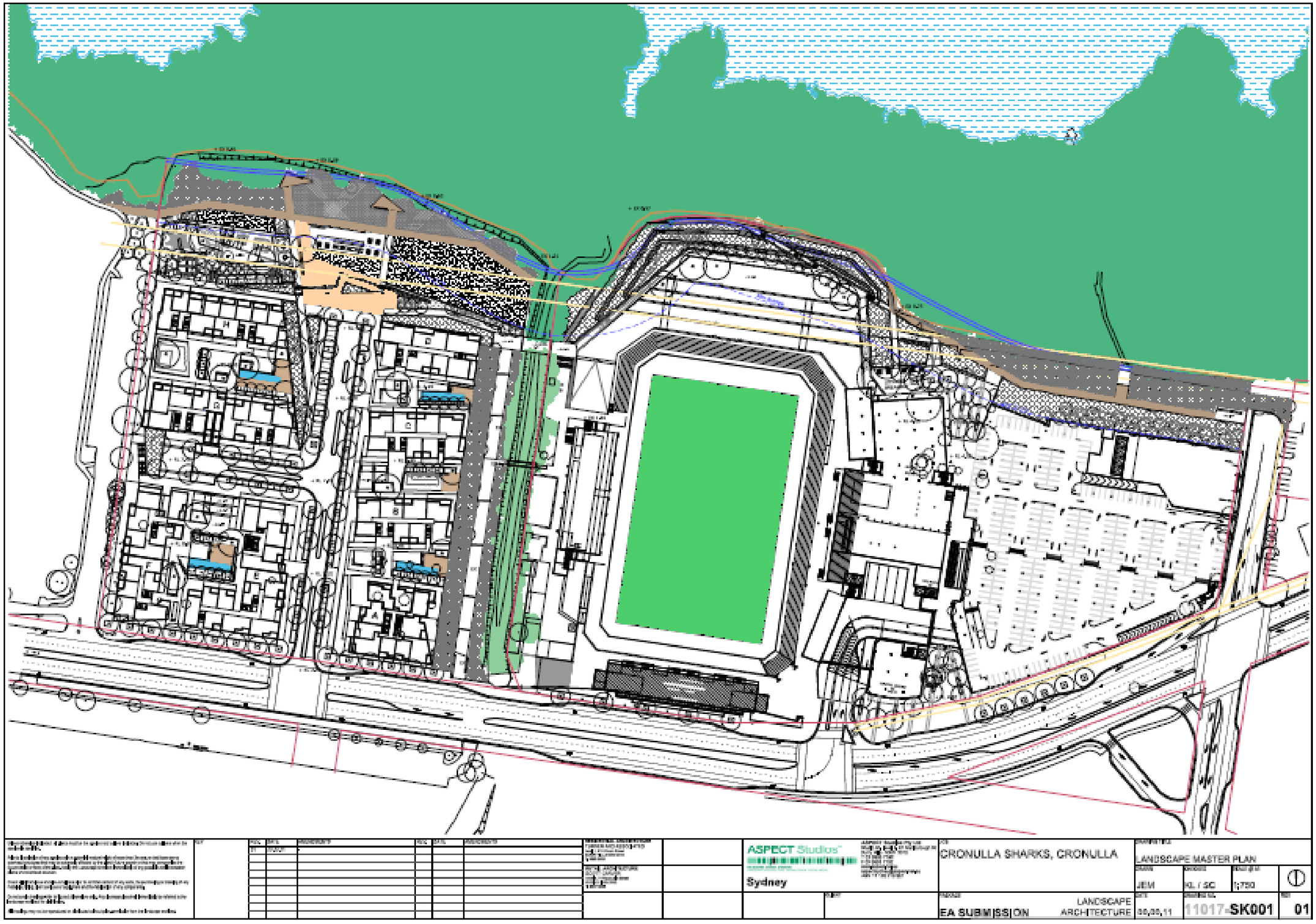
# Appendix A: Concept plan

The concept plan is provided on the following pages.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FOOTPATH
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KID'S TURF
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B
F
E
A
+ RL 2.00
+ RL 4.05
+ RL 8.05
+ RL 8.95
+ RL 6.00
+ RL 7.45
+ RL 8.95
+ RL 5.10
+ RL 2.15
+ EX 2.60
+ EX 1.94
+ EX 3.78
+ EX 7.22
+ EX 3.05
+ EX 0.73
+ EX 1.22
+ EX 1.24
+ EX 1.10
+ EX 3.55
+ RL 4.00
+ RL 4.00
+ RL 4.00
LEISURE BREAKOUT
RETAIL COURTYARD
ENTRY FORECOURT
MEDICAL CENTRE
1:36 LINK TO L2 RETAIL
RIPARIAN PLANTING ZONE
RIPARIAN PLANTING ZONE
BIO RETENTION SWALE
BIO RETENTION SWALE
RIPARIAN BUFFER
RIPARIAN BUFFER
PLANTED BANK
PLANTED BANK

# Appendix B: EPBC Act referral decision

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

**Notification of**
**REFERRAL DECISION – not controlled action**

**Redevelopment of the Cronulla Sharks Leagues Club, Woolooware, NSW (EPBC 2011/5889)**

This decision is made under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

| **Proposed action** | |
|---|---|
| **person named in the referral** | **Bluestone Capital Ventures No.1 Pty Ltd (ACN: 147666206)** |
| **proposed action** | **To redevelop the Cronulla Leagues Club site in Woolooware, including upgrades to the existing clubhouse building, playing fields and training facilities, as well as the development and operation of new retail and residential developments, approximately 2 km north-west of Cronulla, NSW; as described in the referral received by the department on 23 March 2011 and additional information received on 16 May 2011 [see EPBC Act referral 2011/5889].** |

| **Referral decision: Not a controlled action** | |
|---|---|
| **status of proposed action** | The proposed action is not a controlled action. |

| **Person authorised to make decision** | |
|---|---|
| **Name and position** | Michelle Wicks<br>Assistant Secretary<br>Environment Assessment Branch |
| **signature** | mwicks |
| **date of decision** | 17/5/2011 |

# Appendix C: Historical aerial photos


1943 aerial photo


1955 aerial photo


1978 aerial photo


1984 aerial photo


1994 aerial photo


2010 aerial photo

# Appendix D: TSC Act listed species likelihood of occurrence table

Threatened species and communities recorded within a 10 km radius of the site (NSW Wildlife Atlas database search)

| Scientific Name | TSC Status | Habitat | Likelihood of occurrence | Potential impacts |
|---|---|---|---|---|
| **Fauna** | | | | |
| *Calamanthus fuliginosus* Striated fieldwren | V | Uncommon and sedentary occurs in tussocks, swamp-fringes, saltmarsh. Located on adjacent site. | Unlikely | Yes |
| *Oxyura australis* Blue-billed duck | V | Well vegetated freshwater swamps, large dams | No | No |
| *Botaurus poiciloptilus* Australasian bittern | V | In or over water in tall reedbeds, occasionally saltmarsh | No | No |
| *Burhinus grallarius* Bush stone-curlew | E | Open woodland, dry watercourses with fallen branches. The species has been recorded in Towra Point NR | Unlikely | Yes |
| *Esacus neglectus* Beach stone-curlew | E | Open undisturbed beaches, mangroves, tidal mudflats and sandflats. Forage for food in mangroves. The species has been located to the east of the site around Towra Beach | Unlikely | Yes |
| *Cacatua leadbeateri* Major Mitchell's cockatoo | V | Near water on timbered watercourses west of dividing range | No | No |
| *Charadrius leschenaultia* Greater sand plover | V | Wide, sandy or shelly beaches, tidal mudflats, mangroves, saltmarsh. Entirely coastal dwelling in NSW. Exists in mangroves to the north of the site | Likely | Yes |
| *Charadrius mongolus* Lesser sand plover | V | Intertidal mudflats and sandflats in estuaries in NSW. Sandy beaches and mangroves in remainder of Australia. Roosts at Boat Harbour and forages in Towra Point NR. | Unlikely | Yes |
| Limosa limosa Black-tailed godwit | V | Found in sheltered bays, estuaries and lagoons not recorded near the site. | No | No |
| *Thalassarche cauta* Shy albatross | V | Open ocean | No | No |
| *Thalassarche melanophris* Black-browed albatross | V | Open ocean | No | No |
| *Haematopus fuliginosus* Sooty Oystercatcher | V EEC | Intertidal rock and coral reef, occasionally frequents sandspits and tidal mudflats | Unlikely | Yes |

| Scientific Name | TSC Status | Habitat | Likelihood of occurrence | Potential impacts |
|---|---|---|---|---|
| | species | The species has been recorded to the west and east of the site | | |
| *Haematopus longirostris* Pied oystercatcher | V EEC species | Undisturbed beaches, sandspits, sandbars, mudflats and estuaries. Five breeding pairs have been recorded in Woolooware Wetlands to the west of the site. | Unlikely | Yes |
| *Sterna albifrons* Little tern | E | Coastal waters, saltfields, sewerage ponds near coast. Towra point is significant breeding ground | Unlikely | Yes |
| *Sterna fuscata* Sooty tern | V | Tropical, subtropical seas, cays. | No | No |
| *Xanthomyza Phrygia* Regent honeyeater | E | Ironbark woodland | No | No |
| *Pterodroma nigripennis* Black-winged petrel | V | Open ocean and coastal waters | No | No |
| *Lathamus discolor* Swift parrot | E | Forests, woodlands and plantations, banksias | No | No |
| *Polytelis swainsonii* Superb parrot | V | Riverine and white box woodland west of dividing range | No | No |
| *Glossopsitta porphyrocephala* Purple-crowned lorikeet | V | Predominantly an inland species, found occasionally on the coast | No | No |
| *Callocephalon fimbriatum* Gang-gang cockatoo | V | Woodlands and opened forests | No | No |
| *Ptilinopus superbus* Superb fuit dove | V | Forests mainly in Queensland and northern NSW | No | No |
| *Pandion haliaetus* Osprey | V | Occur predominately in coastal estuaries and lagoons. Use large dead trees as nesting sites. Potential roosting habitat in study area | Unlikely | Yes |
| *Puffinus carneipes* Flesh-footed shearwater | V | Nesting sites located in a variety of vegetation communities including forests, shrubland and grasslands | No | No |
| *Rostratula benghalensis australis* Painted snipe | E | Inland and shallow coastal freshwater wetland systems | No | No |
| *Scoteanax rueppelli* Greater broad-nosed bat | V | Roost in hollows of large old trees | No | No |
| *Thinornis rubricollis* Hooded plover | E | Preference for open beaches and associated dunes, rockshelves and tidal areas. | Likely | Yes |
| *Diomedea exulans* Wandering albatross | E | Open oceans | No | No |
| *Calidris tenuirostris* Great knot | V EEC species | Tidal mudflats, sandy ocean and bay shores, estuaries. Potential forager in the study area | Unlikely | Yes |

| Scientific Name | TSC Status | Habitat | Likelihood of occurrence | Potential impacts |
|---|---|---|---|---|
| *Limicola falcinellus* Broad-billed sandpiper | V | Tidal mudflats near mangroves, sand flats on seaward side of estuaries preferred. Potential forager in the study area | Unlikely | Yes |
| *Xenus cinereus* Terek sandpiper | V EEC species | Tidal mudflats, estuaries, shores and reefs or islands, coastal swamps. Roost communally amongst mangroves or dead trees. Located within Towra Pt reserve | Unlikely | Yes |
| *Ninox strenua* Powerful owl | V | Pairs occupy large home range in forests, woodland, coastal forests | No | No |
| *Tyto novaehollandiae* Masked owl | V | Wet and dry sclerophyll forests, required large tree hollows for nesting | No | No |
| *Calidris alba* Sanderling | V | Preference for low open beaches and tidal mudflats. Observed on ocean beaches in Cronulla | No | No |
| *Litoria aurea* Green and golden bell frog | E | Permanent freshwater wetlands with dense reeds. Recorded at Towra Point | No | No |
| *Eubalaena australis* Southern right whale | V | Open ocean and coastal waters | No | No |
| *Megaptera novaeangliae* Humpback whale | V | Open ocean and coastal waters | No | No |
| *Dugong dugon* Dugong | E | Open ocean and coastal waters, estuaries in seagrass meadows | No | No |
| *Arctocephalus forsteri* New Zealand fur-seal | V | Open ocean, coastal waters roost on rock platforms, island rockeries | No | no |
| *Arctocephalus pusillus doriferus* Australian Fur-seal | V | Open ocean, coastal waters, roosts on rock ledges and island rockeries | No | No |
| *Pteropus poliocephalus* Grey-headed Flying-fox | V | Roosts in large camps usually in densely vegetated gullies, Known to chew leaves and eat salt glands of mangroves. Found on site | Known | Yes |
| *Chelonia mydas* Green Turtle | V | Open ocean, shore to nest | No | No |
| *Phascolarctos cinereus* Koala | V | Eucalypt woodlands | No | No |
| **Flora** | | | | |
| *Eucalyptus scoparia* | E | Well drained granitic hilltops | No | No |
| *Syzygium paniculatum* | V | Rainforest gullies | No | No |
| *Caladenia tessellate* Thick lip spider orchid | E | Open woodland | No | No |
| **Communities** | | | | |
| Coastal saltmarsh in Sydney Basin | E | Estuarine tidal flats generally adjacent to mangrove forests | Likely | Yes |
| Swamp oak forest | E | Identified by DECC as potential habitat | Likely | Yes |

| Scientific Name | TSC Status | Habitat | Likelihood of occurrence | Potential impacts |
|---|---|---|---|---|
| | | and required consideration. Not identified on site or adjacent to site | | |
| Taren Point shorebird community | E | Community if restricted to a site located to the 3km NW of the proposed site. Species within this community such as Bar-tailed Godwit and Eastern Curlew have been recorded on site | Likely | Yes |

V = listed as vulnerable under the TSC Act, E= endangered under the TSC Act. EEC species = species listed as part of the Taren Point shorebird community.

# Appendix E: Tests of significance

The assessment of significance (7-part test) is applied to species, populations and ecological communities listed on Schedules 1, 1A and 2 of the *Threatened Species Conservation Act* and Schedules 4, 4A and 5 of the *Fisheries Management Act*. The assessment sets out seven factors, which when considered, allow proponents to undertake a qualitative analysis of the likely impacts of an action and to determine whether further assessment is required via a Species Impact Statement (SIS). All factors must be considered and an overall conclusion made based on all factors in combination. An SIS is required if, through application of the 7-part test, an action is considered likely to have a significant impact on a threatened species, population or ecological community.

The following tables outline the specific requirements, distribution and habitat of threatened species and communities that are likely to utilise the site or adjacent mangroves. Also included in this table are the species requirements for the birds that form the shorebird community occurring on the relict tidal delta sands at Taren Point (TPS EEC). The 7 part tests for EECs and threatened species follow.

**Requirements and general descriptions of faunal species listed under the TSC Act or species that form part of the TPS EEC**

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Charadrius leschenaultia* | Greater sand plover | Migratory | V | | Wide, sandy or shelly beaches, tidal mudflats, mangroves saltmarshes. Is a coastal dweller in NSW. | Have been recorded at Boat Harbour to the west of the site, with potential foraging habitat existing on and to the north of the site. | Forages in mangroves, saltmarshes, dunes, beaches and tidal mudflats, preys on a variety of invertebrates. | Migrates to Australia in Summer from Turkey to Siberia | Regular summer migrant to Australia, common along coast in all states. |
| *Xenus cinereus* | Terek sandpiper | Migratory | V | Yes | Coastal on tidal mudflats, estuaries, shores and reefs of islands, coastal swamps, embayments, harbours, lagoons and mangroves. Occurs less often on sandy or shingle beaches, or on rock or coral reef platforms. The species mostly forage in the open on soft wet intertidal mudflats, especially near mangroves, and roost in and among mangroves | Surrounding mud and sandflats are likely to provide foraging habitat for Terek sandpiper, The species is known to utilize mangroves however no roosting sites near the site have been established, they are known to occur in Towra Point wetlands. | Crustaceans and insects are taken by the Terek sandpiper, but extralimitally, seeds, molluscs and arachnids are also taken. | Terek sandpiper migrates from their breeding grounds in Eurasia to various areas in Africa, the Persian Gulf, SE Asia, New Guinea and Australia. The species arrive in Australia between August to September, and leaves by May. Some, probably immatures, remain behind for the Austral winter, especially in the NT. | Terek sandpiper rarely filter far southwards, and mostly remain along coastal areas in Australia's north. |
| *Esacus neglectus* | Beach stone-curlew | Migratory | E4A | | The species is exclusively coastal and occurs on all types of beaches. The species forage on large intertidal mudflats, sandflats, sandbanks and sandspits exposed by low tide, on open beaches or near river mouths, and breed at the back of sandy beaches, and occasionally on sandbanks or coral ridges, on islands or open coast. | There is foraging habitat in the stand of mangroves on and adjacent to the site. Is known to frequent Towra Point reserve. | The beach stone-curlew feed on crabs and other hard-shelled marine invertebrates | The beach stone-curlew is mainly sedentary, though vagrants have been recorded far south of its usual range. | Coastal regions mostly along the northern parts of the continent. |
| *Sterna albifrons* | Little tern | Migratory | E4A | | The species is almost exclusively coastal, nesting in small colonies in dunes or sandy beaches adjacent to estuaries.<br>Known to forage in shallow estuarine waters | Surrounding the study area, mud and sandflats are likely to provide foraging habitat for the little tern. No suitable habitat on-site, but are known populations on the Kurnell peninsula at Boat Harbour. | Feeds on small fish, crustaceans and insects found on beaches or in estuaries | Migrates from eastern Asia, arriving in NSW from September to November. Species leave Australia by May | Coastal regions, mainly north of Sydney. Known population at Boat harbour on the Kurnell peninsula. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Calidris tenuirostris* | Great knot | Migratory | V | Yes | Medium sized waders occur within sheltered coastal habitats with associated intertidal mudflats. Often utilize tidal mudflats, sandy ocean and bay shores, estuaries, shallow saline wetlands, occasionally forager and roosts in mangroves | Potential foraging habitat for this species exists within the mangroves and mudflats to the north of the site. | The great knot is carnivorous feeding on a range of invertebrate prey including molluscs, annelids, crustaceans, as well as vegetable matter such as berries and seeds. Foraging takes place day and night on intertidal mud and sandflats, generally along the edge of the receding tide. | Breeds in Siberia and migrates to India, SE asia and arrives in coastal Australia between September – March. | The great knot breeds in Siberia and occurs sporadically throughout Asia. The species is a non-breeding migrant to Australia and is scarce in the south east of the continent. |
| *Limicola falcinellus* | Broad-billed sandpiper | Migratory | V | | Prefers the sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, and lagoons. Occasionally, occur on reefs or rocky platforms. The species forages on exposed flats of soft mud or wet sand at edges of coastal and near-coastal wetlands, especially mangroves, and roosts on banks on sheltered beaches, and beaches near mangroves. | Surrounding mud and sandflats are likely to provide foraging and roosting habitat. Unlikely to utilize habitat on site. | Omnivorous. Feeds on worms, molluscs, crustaceans, insects, seeds and occasionally rootlets and other vegetation | The broad-billed sandpiper migrates from its arctic nesting grounds in Siberia from the Bay of Bengal in July-August to the northern coast of Australia in small numbers. The return journey occurs through April-May | The broad-billed sandpiper is most common in north and northwest coasts but also occur regularly in scattered coastal locations in the south. |
| *Pandion haliaetus* | Osprey | Resident | V | | Prefer coastal habitats including the mouth of large rivers, estuaries, bays and inlets. Tend to roost in large dead trees. | Foraging habitat exists however unlikely to roost as no potential trees are present on site | Mainly small to medium fish | Sedentary in Australia although have wide range | Live throughout coastal areas of Australia |
| *Haematopus longirostris* | Pied oystercatcher | Resident | V | Yes | Undisturbed sandy beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands. It forages on sand, mud and rock and may be far from the water's edge. In Australia the species has been recorded feeding in pasture. Roosting habitat is similar to that described above. | Intertidal areas in the surrounding wetlands may provide nesting habitat for the species. The species is known to occur in the wetlands to the north of the site. | The pied oystercatcher feeds on annelids, molluscs, crustaceans and occasionally small fish. Feeding occurs predominately at low tide. | Not a migratory species but local scale movements from breeding grounds to non-breeding flocking areas recorded in some parts of Australia. | In Australia, the pied oystercatcher occurs along all coasts and offshore islands. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Charadrius leschenaultii* | Greater sand-plover | Migratory | V | | Almost entirely restricted to coastal areas on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. The species forage on the surface of wet mud or sand of open intertidal flats rather than in shallow water and roost on sand-spits and banks on beaches or in tidal lagoons. | Potential foraging habitat in surrounding adjacent mangroves. | Appear to be carnivorous, but on one occasion has been recorded eating plant material. Molluscs, worms, crustaceans, insects and lizards are taken by this species. | The greater sand-plover migrates from its breeding grounds in central Asia from mid-July to August to the northwest coast of Australia. The return journey occurs between March and April | The greater sand-plover is most abundant in the south east of the Gulf of Carpentaria. It is less abundant, but widespread, along the eastern coast from Torres Strait to the south east. |
| *Charadrius mongolus* | Lesser sand-plover | Migratory | V | | Usually coastal, in littoral and estuarine environments, rarely inland. Tidal mudflats and sandflats, gently sloping sandy and shelly beaches, saltmarsh, estuaries and mangroves are favoured. Forages on freshly exposed intertidal mudflats and sandflats of estuaries and beaches and roosts on beaches, banks, spits and bars of sand or shells on beaches or in estuarine lagoons. | Surrounding the study area, mud and sandflats are likely to provide foraging habitat for the lesser sand-plover. Has been located in Towra Point wetlands, and roosts every year at Boat Harbour.. There is no suitable roosting habitat on site, although foraging habitat exists. | Mostly carnivorous but has been once recorded eating seeds. Prefers molluscs, worms, crustaceans and insects. | The lesser sand-plover migrates from its breeding grounds in Siberia from September-October to Australia and spread down the western and eastern coasts. The return migration occurs around March-April. | The lesser sand-plover is widespread from southeast Gulf of Carpentaria, north to Torres Strait and along the entire eastern coast. There are rare inland records for this species. |
| *Charadrius mongolus* | Lesser sandplover | Migratory | V | | Inhabits intertidal mudflats and sandflats in NSW estuaries. Also known to inhabit sandy beaches and mangrove forests. | Known to utilize Towra point | Forages in mangroves, saltmarshes, dunes, beaches and tidal mudflats, preys on a variety of invertebrates. | Breeds in Siberia and migrates to Australia in Summer. | Regular summer migrant to Australia, common along coast in all states. |
| *Thinornis rubricollis* | Hooded plover | Resident | E4A | | Inhabits broad sandy beaches with seaweed and adjacent dunes, occasional inhabitant of tidal mudflats | Potential habitat exists within the mudflats to the north of the site, There are records of the species on Wanda Beach to the SE of the site. | Forages in mangroves, saltmarshes, dunes, beaches and tidal mudflats, preys on a variety of invertebrates | Mostly resident, maintaining territories throughout the year, | Confined to suitable habitat from Jervis Bay to Bass Strait, the Bight coast of SA and coastal southern WA. Kurnell peninsular is its most northern limit. |
| *Haematopus fuliginosus* | Sooty oystercatcher | Resident | V | Yes | Intertidal rocky and coral reefs, mostly on ocean shores, breeds mostly on offshore islands, occasionally frequents sandspits and tidal mudflats. | The study area is likely to provide only marginal foraging habitat for the sooty oystercatcher since this species prefers to forage on rocky intertidal areas and nest on rocky offshore islands. Has been located to the west and east of the site. | Molluscs, crustaceans, polychaetes, ascidians, echinoderms and small fish. | Mostly resident, maintaining territories throughout the year. The species often move to offshore islands to roost | Widespread in coastal eastern, southern and western regions. Mostly recorded in Bass Strait |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Pteropus poliocephalus* | Flying fox | Resident | V | | This species inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. Utilises such habitats for foraging and roosting. Large roosting camps (upto 200 000 individuals) are located in gullies, typically close to water, in vegetation with a dense canopy | Grey-headed flying fox has been recorded on site in recent field studies and is known from the locality. The vegetation within the study area provides foraging habitat, with a colony of the species known to roost in the Kurnell peninsula. | Species have been recorded travelling long distances on feeding forays. Fruits and flowering plants of a wide variety of species are the main food source. | Maintaining territories throughout the year. | Known roosts occur on the Kurnell peninsula |
| *Calamanthus fuliginosus* | Striated fieldwren | Resident | V | | The striated field-wren occurs in low shrubs, tussocks, swamp fringes, saltmarsh, coastal heaths and dune vegetation. This species is uncommon and sedentary and only occurs on the mainland from north east of Sydney through south coast to Lake Alexandria. | Records show the striated field-wren occurring in Towra Point Nature Reserve approximately 3 km to north east of the subject site. Unlikely to utilise site. | Forages in saltmarsh communities, variety of invertebrate prey | Mostly resident, maintaining territories throughout the year. | Botany Bay to Victoria coast and Tasmania. |
| *Burhinus grallarius* | Bush stone-curlew | Resident | E 1 | | Inhabits open woodlands, dry watercourses with fallen branches. | The species has been recorded in Towra Point NR with potential habitat occurring along the northern edge of the study site. | Variety of invertebrate prey, including hard shelled aquatic invertebrates. | Mostly resident, maintaining territories throughout the year | Majority of coastal and inland Australia (absent from southern inland regions, including the Nullabor). |
| *Limosa lapponica* | Bar-tailed godwit | Migratory | | Yes | Utilises saline and tidal mud flats and sands of coastal inlets, estuaries and nearby salt pans. Occasionally forage in paddocks next to estuaries, particularly after heavy rains. Usually forage near edge of water or in shallow water particularly around beds of seagrass and will occasionally forage amongst mangroves | Mangroves on and to the north of the site may also occasionally provide foraging habitat for the species. Has been recorded foraging in the mangrove regions adjacent to site* | Variety of invertebrate prey including worms, molluscs and insects which it gleans from the sandy and muddy substrates by probing with its bill. Feeding times vary with tides and time of year though the in some locations at least, the species will feed for alomst the entire time the feeding grounds are exposed. | Leave their breeding grounds in Alaska, Siberia and islands of the Berring Sea in July-August and move south along the asian coast or across the pacific arriving in northern Australia in August to mid-November. The species arrives in the south-east of Australia around October and starts the return from February to April. | Non-breeding migrants throughout coastal Australia. Breeds in north eastern Siberia to Alaska around June and July. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Tringa nebularia* | Common greenshank | Migratory | | Yes | The common greenshank occurs in a range of habitats from inland wetlands to coastal habitats. Coastal habitats typically contain large mudflats, saltmarsh, mangroves or seagrass. The species typically forages at the edges of wetlands amongst fringing vegetation including mangrove pneumatophores, saltmarsh or sedges and will occasionally feed on exposed mudflats. Roosting occurs on slightly elevated rocks, sandbanks or small muddy islets. | There is no suitable habitat on site, sand and mudflats in adjacent regions provided suitable habitat | The common greenshank is carnivorous, feeding on a range of invertebrate prey including molluscs, crustaceans and insects as well as some smaller vertebrates such as frogs and lizards. The species displays both diurnal and nocturnal feeding habits, wading in shallows along the edge of water in intertidal habitats. | Migration southward occurs between July and September with birds moving south along the Asian coast to Australia. The species arrives in south eastern Australia during August and September. Northward return migration begins in March with the majority of birds leaving in April. | The common greenshank breeds in the northern hemisphere and occurs broadly through Eurasia including the British Isles, Scandinavia and Russia. Outside of the breeding period, the species can be found in Europe, Africa, Asia and Australasia. |
| *Actitis hypoleucos* | Common sandpiper | Migratory | | Yes | The common sandpiper occurs in a wide range of wetland habitats from estuarine mudflats and stream deltas, to margins of lakes, pools, billabongs and dams. In some areas, the species shows a preference for rocky areas and is thought not to prefer large coastal mudflats. It forages on the edges of wetland and in shallow water also utilising grassy areas adjoining wetlands. Roost sites are typically on rocks or branches with mangroves often utilised. | Habitat for the common sandpiper within the study area includes foraging habitat in the form of mudflats, mangroves and, less likely, the turfed reserve area. | The common sandpiper is carnivorous, taking a range of invertebrate prey including mollusks, crustaceans and insects as well as worms, spiders and some vertebrate prey such as frogs, fish and tadpoles. Foraging is diurnal. | The common sandpiper leaves its breeding grounds in Eurasia in mid-July to early September. Eastern Eurasian populations migrate south diurnally along coasts through Asia and arrive in north western Australia in July and in Queensland and south east Australia from August. The return journey from NSW occurs between March and April | Non-breeding migrants to Australia. Breeds in Eurasia. |
| *Calidris ferruginea* | Curlew sandpiper | Migratory | | Yes | The curlew sandpiper inhabits intertidal mudflats in estuaries, bays, inlets and lagoons and may also occur within non-tidal lagoons, swamps and lakes. At low tide, the species forages on mudflats and edges of shallow pools and drains, while at high tide curlew sandpipers feed amongst emergent vegetation, flooded paddocks or inundated saltmarsh. The species roosts on beaches, sandspits and islets and occasionally within saltmarsh. | Mangroves in the region of the reserve may provide occasional foraging habitat during periods of high tide. | The curlew sandpiper is omnivorous, feeding on a range of invertebrates as well as seeds. Foraging occurs both diurnally and nocturnally by probing, jabbing and gleaning the muddy substrate. | The curlew sandpiper leaves its breeding grounds in Siberia in July and August migrating overland through Siberia then into China, Burma and south east Asia arriving in the NW of Australia from mid-August. The curlew sandpiper reaches the south east of Australia in August - September. The return journey begins in March. | Non-breeding migrants to Australia with breeding restricted to high arctic of northern Siberia. Non-breeding population widespread east of the Great Divide in NSW and concentrated in coastal regions. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Numenius madagascariensis* | Eastern curlew | Migratory | | Yes | The eastern curlew inhabits estuaries, embayments, inlets and coastal lagoons where it forages on intertidal mudflats or sandflats often with seagrass beds. Foraging also occasionally within saltmarsh. The species typically roosts near high water mark on dry sand or among coastal vegetation including mangroves and saltmarsh. | Mangroves on and adjacent to the site provide foraging habitat, with the species being located on site. | The eastern curlew is carnivorous taking crabs, small molluscs and insects from the mudflats and sandflats by probing seagrass during low tide or by locating by site. Feeding varies between genders with males feeding in loose flocks in seagrass while females feed solitarily on mud and sandflats. | Leaves its breeding grounds in Russia and north eastern China from mid-July migrating south and generally staying within 100m from shore. Birds arrive in eastern Australia in July and moving down the east coast until February. The eastern curlew begins its return migration between February and March. | The eastern curlew breeds in Russia and north eastern China and spends the non-breeding period in northern and eastern Australia. In NSW, the species occurs continuously along the coast. |
| *Heteroscelus brevipes* | Grey-tailed tattler | Migratory | | Yes | Occurs on sheltered coasts in a range of habitats ranging from reefs and rocky platforms to mudflats and less commonly sandflats or embayments, lagoons and estuaries. Often associated with mangroves in which the species roosts. May also roost in dense stands of shrubs, on snags and driftwood or on man-made structures such as jetties, seawalls and causeways. It foragers on hard intertidal substrates but may use intertidal mudflats particularly in proximity to mangroves. | Mangroves in the south east of the study area may provide roosting habitat, although this is unlikely and the bird has never been recorded in the immediate surrounds. | Feeds on a range of macroinvertebrates including annelids, molluscs, crustaceans and insects and will occasionally take fish. Feeding occurs at during the day. | Leave breeding grounds in Siberia from August and move south, mainly along the coast of Asia to the north coast of Australia where they arrive in late August to early September. Arrive on the south east coast of Australia from September to November. The grey-tailed tattler departs south east Australia by April returning to breeding grounds in the northern hemisphere. | The grey-tailed tattler is a non-breeding migrant to Australia. The species breeds in Siberia with non-breeding populations found throughout Asia and Australasia. Within Australia, the species is found along much of the coast of NSW and other states. |
| *Pluvialis squatarola* | Grey plover | Migratory | | Yes | Inhabits large intertidal mudflats and sandflats of estuaries, lagoons, embayments and harbours and less commonly saltpans and margins of saltlakes inland. The grey plover forages on intertidal mudflats and sandflats by day and occasionally nocturnally. The grey plover will rarely forage on pasture. Roosting occurs on unvegetated sandbanks. | Mudflats to the north of the site may provide habitat. The bird has not been recorded in the vicinity of the site. | The grey plover is mostly carnivorous taking a range of invertebrate prey including molluscs, annelids, insects and crustaceans. Fruits and seed are also occasionally taken. | The grey plover breeds in the Arctic, migrating south in July to September, to winter in all southern continents. Birds which spend the austral summer in Australia presumably come from northern Asia travelling down the Asian coast and arriving in the north and northwest coast in September. The grey plover reaches maximum numbers in NSW around December. The return journey occurs through March and April . | The grey plover breeds in the Arctic tundras and during the non-breeding period can be found throughout coastal areas of the southern continents. The species is uncommon in NSW, occurring in coastal areas and rarely reaching inland. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Gallinago hardwickii* | Latham's snipe, Japanese snipe | Migratory | | Yes | Inhabits freshwater wetlands and saltmarsh and prefer open freshwater fringed by vegetation. Occupy a range of fringing vegetation including grassland, sedges, reeds and rushes, coastal heath and saltmarsh. Forages on muddy substrates or shallow water at edges of wetlands and roosts in vegetation fringing foraging areas. Will occasionally roost in dense tea-tree scrub or on feeding grounds if no suitable cover available. | The study area is unlikely to provide significant habitat for this species as saline estuaries are rarely frequented. | Foragers predominately at dawn and dusk for a range of macroinvertebrates and plant material. | The Latham's snipe breeds in Japan and migrates to Australia for the austral summer. Birds are thought to fly directly from Japan to Australia, stopping at a few staging areas. The birds fly south over the Japanese islands, Taiwan and New Guinea to arrive in northern Australia in July to September. Birds leave Australia by February. | The Latham's snipe is a non-breeding migrant to Australia. In NSW it can be found on the coast and as far inland as the western slopes of the Great Dividing Range. The species breeds in Japan and east Asian mainland. |
| *Tringa stagnatilis* | Marsh sandpiper | Migratory | | Yes | Occur in swamps, lagoons, saltpans, saltmarshes, estuaries, inundated floodplains and intertidal mudflats. Infrequently recorded around mangroves in the south east of Australia. The species forages on the edge of wetland areas where it wades in shallow water. Roosts on tidal mudflats near saltmarsh. | Unlikely to provided substantial habitat, utilized mangroves very infrequently. | The marsh sandpiper is carnivorous taking insects and molluscs from shallow water. Aquatic insects make up a large portion of the species prey | The marsh sandpiper breeds in southern Siberia, eastern Europe and northern China and migrate south for the austral summer. Birds arrive in Australia in September-December. The birds' migration from Australia in March and April. | A non-breeding migrant to Australia, in NSW the species has been recorded most frequently from the central and south coast. |
| *Vanellus miles* | Masked lapwing | Resident | | Yes | The masked lapwing is a common species and inhabits a wide range of habitats from farmland, pasture, playing fields, fresh or saline wetlands, saltmarsh and dams. Forages and nests on the ground in both natural and artificial habitats. | Likely to provide habitat. | The masked lapwing is carnivorous taking a range of macroinvertebrate prey. May also occasionally eat plant material and small frogs. | The masked lapwing is a sedentary species and does not undertake migration. | The masked lapwing is widespread across the eastern stated of Australia but largely absent from the west of the continent. |
| *Pluvialis fulva* | Pacific golden plover | Migratory | | Yes | Primarily a coastal species, usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Occasionally found around mangroves and saltmarsh with sparse *Sarcocornia* spp. or in paddocks with short grass. Roosts in proximity to feeding grounds on beaches or spits or among vegetation including saltmarsh and mangroves. | The species may infrequently visit the mangrove vegetation to the north of the site. No roosting sites have been located in these mangroves. | The Pacific golden plover feeds on a range of macroinvertebrates and may also take plant material such as seeds and leaves and vertebrate prey such as lizards, bird's eggs and small fish. | The species breeds in the Arctic and migrates south for the austral summer. Birds leave breeding grounds in July and August and travel south through Asia to Australia. Reach south east Australia in September and begin the return journey from mid-February to May. | Breeds in Alaska and Siberia and during non-breeding period can be found throughout Asia, and Australasia. In NSW the species is widespread along coastal regions. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Calidris canutus* | Red knot | Migratory | | Yes | Inhabit coastal and estuarine sandflats and mudflats and rarely occur inland (Schodde and Tidemann 2003). Forage on sandflats and mudflats exposed by low tide and often at the water's edge. Also occasionally feed amongst exposed seagrass on tidal sandflats. Roost on sandy beaches, spits and mudflats. | Unlikely to provide substantial habitat on site, species known to occur in Taren Point. | On non-breeding grounds the red knot feeds on crustaceans, worms, insects and molluscs. On breeding grounds, the red knot is more insectivorous and herbivorous. | The red knot breeds high within the Arctic circle and those nesting in far northeastern Siberia and northwestern Alaska migrate down the western shores of the Pacific Ocean in August and September to Indonesia, Australia and New Zealand. The return migration occurs around May. | Groups arriving in Australia may arrive in 2 separate fronts: one on the beaches of northwest coast without filtering south along the west coast in any great numbers, and the other along the northeast coast of Queensland from which they disperse further south. |
| *Calidris ruficollis* | Red-necked stint | Migratory | | Yes | Inhabit mainly coastal areas in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks, sometimes on protected sandy or corraline shores, and occasionally on exposed or ocean beaches.. The species forage on bare wet mud on intertidal mudflats or sandflats, or in very shallow water, and roost on sheltered beaches, spits, banks or islets of sand, mud, coral or shingle, often in saltmarsh vegetation. | Unlikely to provide foraging or roosting habitat. | Omnivorous. Worms, tiny crustaceans, snails and insects may be taken, and seeds have been observed to be taken extralimitally. Diet appears to vary between months | The red-necked stint has a migration route that swings in a huge arc. From breedings grounds in Siberia and Alaska, the red-necked stint migrates from June to August south through Mongolia, China and Japan, partly inland and partly along the coast to arrive in Australia. The return migration occurs from early March to mid April | Red-necked stint arrive in a broad front across the northern Australian coast. Some stop there, while others continue across the continent to centres along the south coast to gather in tens of thousands |
| *Arenaria interpres* | Ruddy turnstone | Migratory | | Yes | Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. The species mainly forage between lower supralittoral and lower littoral zones of foreshores, from strand-line to wave-zone, and roost or loaf on beaches, above tidelines among rocks, shells, beachcast seaweed or other debris, rocky islets among grassy tussocks and on mudflats and sandflats. | Mud and sandflats in the surrounding wetland area may provide foraging habitat for this species. No suitable habitat on site. | Carnivorous. The species has been recorded taking Insects, worms, crustaceans, molluscs, spiders, and occasionally eggs and carrion. | The ruddy turnstone breeds in Siberia and Alaska and migrate from August to September to the northwest coast of Australia and Torres Strait. The return migration occurs between March and April. Some individuals, probably non-breeding immatures, stay behind to winter in Australia. | From arrival at the northwest coast of Australia, the ruddy turnstone spreads around the coast, with some flying across the continent to points on southern shores. |

| Species name | Common name | Migratory/Resident | TSC listing | TPS EEC | Habitat requirements in Australia | Habitat within study area | Diet | Migration route | Distribution |
|---|---|---|---|---|---|---|---|---|---|
| *Calidris acuminata* | Sharp-tailed sandpiper | Migratory | | Yes | Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. The species forage and roost at the edge of the water on wetlands or intertidal mudflats, either on bare wet mud or sand, or in shallow water, but also forage and roost among inundated vegetation of saltmarsh, grass or sedges. | Mud and sandflats in surrounding wetlands may provide foraging and roosting habitat for this species. Unlikely to exist on site. | Omnivorous. Seeds, worms, molluscs, crustaceans and insects, as well as aquatic plants are eaten by this species. | The species breed on the NE tundra in Siberia and migrates from late July to September. Passing over Mongolia,China and down the Asian coast, the birds strike over the Pacific through the Philippines to Australia and New Zealand. The return migration occurs in April-May, although some individuals remain behind | Sharp-tailed sandpipers arrive in a broad front across the north coast of Australia. They travel across the continent to concentrate in greatest numbers in the south eastern quarter. |
| *Numenius phaeopus* | Whimbrel | Migratory | | Yes | Inhabits intertidal mudflats of sheltered coastal lagoons, estuaries, harbours and river deltas where it forages in open unvegetated areas or among mangroves. Roost in mangroves either on branches or on the ground, or in shallow water. | Mud and sandflats are likely to provide foraging habitat for the whimbrel as well as roosting habitat. May frequent the site as is known to forage in mangroves. | The whimbrel is carnivorous, taking a range of macroinvertebrate prey including annelids, crustaceans and molluscs. Plant material such as berries and seeds as well as vertebrate prey such as lizards are also rarely taken. | The whimbrel travels from breeding grounds in the arctic tundra of eastern Siberia south through eastern Asia. Birds begin their migration from breeding grounds in July and arrive in the north of Australia in August – October, moving south The return journey occurs from April through May. | Subspecies *variagatus* is the only one of four subspecies to migrate to Australia. This subspecies breeds in Siberia. During the non-breeding period is a frequent visitor to Australia. In NSW the species has been recorded coastally with some inland records. |

## SEVEN PART TESTS

7-part tests for three EECs are presented below followed by a table of 7-part tests for threatened species.

### Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions

This community is found on the coastal floodplains of NSW. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees, being located in close proximity to rivers and estuarine with saline influences. This community is generally characterised by *Casuarina glauca, Melaleuca ericifolia, Baumea juncea, Entolasia marginata, Gahnia clarkei, Hypolepis muelleri, Phragmites australis* and *Viola hederacea*, although composition of species present varies greatly dependent on soil water levels. This community occurs on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains generally below 20 m (rarely above 10 m) elevation.

A number of threats to the survival of this community have been identified and include:

- Clearing for urban and rural development, and the subsequent impacts from fragmentation
- Flood mitigation and drainage works
- Grazing and trampling by stock and feral animals (e.g. pigs)
- Activation of acid sulfate soils
- Landfilling and earthworks associated with urban and industrial development
- Pollution from urban and agricultural runoff
- Rubbish dumping
- Climate change
- Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species.

There is a small pocket of swamp oak floodplain forest (SOFF) on the northern side of Toyota Stadium. This patch consists of several *C. glauca* with *Acacia* and *Melaleuca* species also present.

**a. In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

This is not a threatened species.

**b. In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

This is not an endangered population.

**c. In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

**i. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

**ii. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

It is likely that some of the SOFF will be cleared to stabilise the hill behind Shark Park, although the exact number of plants to be removed is not yet known. However, the project features planting of species that are consistent with this EEC's composition. Replacement/additional planting will be done in the area of existing SOFF as well as other areas of the development. On balance, there is likely to be an increase in the extent of SOFF on the subject site and an improvement in condition as weeds and rubbish are removed. The local occurrence of this EEC will therefore not be placed at risk of extinction by reduction of extent or modification of composition.

**d. In relation to the habitat of a threatened species, population or ecological community:**

**i. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

The habitat of this EEC is highly modified by past disturbance of the subject site. Landscaping that incorporates species consistent with this EEC will replace part of the bitumen carpark on the eastern land and playing fields on the western land. The hill where the EEC is currently found will be lowered by 1 m and stabilised by engineering structures and revegetation. Overall, this would represent an increase in the extent of available habitat.

**ii. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

The EEC on the subject site exists as an isolated patch. The proposed revegetation would provide greater habitat connectivity, therefore improve on current conditions.

**iii. The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality,**

The EEC within the subject site comprises less than ten trees as an isolated patch. The immediate area is heavily weed infested. There are large areas of this EEC throughout the wider locality, so if this patch of the EEC was cleared it would not affect the survival of the community in the locality.

**e. Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),**

No critical habitat has been declared for this community.

**f. Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,**

There is currently no recovery plan or threat abatement plan for SOFF although priority actions have been identified. The proposal would not conflict with these actions.

**g. Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

The removal of native vegetation is listed as a key threatening process. A number of *C. glauca* trees will be removed as part of the proposal. However, loss of this vegetation will be offset by revegetation using species consistent with the EEC composition (as shown in the landscaping concept plan in **Appendix A**). With weed removal and plantings there will be an overall improvement in the community.

**Conclusion**

The assessment of significance found that there will be an overall improvement in the extent, condition and connectivity of SOFF as a result of the proposed development because loss of a small patch of SOFF at the northern end of Toyota Stadium will be offset by a larger area of revegetation using species consistent with the SOFF EEC. On the basis of the above considerations, it is unlikely that the proposal will result in a significant impact on SOFF. Consequently, a Species Impact Statement is not required for the proposal with respect to this community.

**Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions**

Coastal saltmarsh is found in the upper limits of the inter-tidal zone of coastal estuaries and saline or brackish lagoons. This means they are only intermittently flooded by medium to high tides and the flora and fauna are specially adapted to highly saline environments (saltier than the sea). Saltmarsh is often found between mangrove stands and saline forest types such as the SOFF EEC. West *et al.* (1985) estimated the total area of coastal saltmarsh in NSW was approximately 5700 ha distributed in fragmented patches mostly less than 100 ha.

There are over 200 plant species that occur in the coastal saltmarsh environment and as such not all the species listed below need to be present at any one site for it to constitute coastal saltmarsh. Species within the coastal saltmarsh EEC include, but are not limited to, grey mangrove (*Avicennia marina*), river mangrove (*Aegiceras corniculatus*), swamp paperbark (*Melaleuca ericifolia*), *Baumea juncea*, knobby club rush (*Ficinia nodosa*), sea rush (*Juncus kraussii*), creeping brookweed (*Samolus repens*), samphire (*Sarcocornia quinqueflora*), swampweed (*Selliera radicans*), saltwater couch (*Sporobolus virginicus*), austral seablite (*Suaeda australis*), streaked arrowgrass (*Triglochin striata*) and prickly couch (*Zoysia macrantha*).

Saltmarsh EEC has not been found within the Sharks development site but does exist in nearby areas (e.g. patches along Captain Cook Drive, the margins of mangroves to the east and west, and large communities within nearby conservation reserves). Indirect impacts associated with the proposal (e.g. changes to drainage – which are unknown at this stage) may affect nearby patches of saltmarsh.

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

Saltmarsh community is not a threatened species.

**b) "In the case of an endangered population whether the life cycle 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".**

This is not an endangered population.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

**i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

**ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Indirect impacts are likely to include changes in surface water drainage. These impacts (if any) are expected to be localised and not affected the significant areas of saltmarsh in the broader study area (e.g. in conservation reserves). The EEC is therefore unlikely to be at risk of local extinction.

**d) in relation to the habitat of a threatened species, population or ecological community:**

**i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

**ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

**iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

It is difficult to assess indirect impacts based on the information available for concept plan. It is possible that patches of saltmarsh could be indirectly affected by changed conditions/habitats associated with the proposed development. However, there are no significant areas of saltmarsh in the immediate vicinity of the development area and only small, isolated patches could be affected.

**e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),**

No areas of critical habitat occur on or adjacent to this site.

**f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,**

Not required

**g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

The removal of native vegetation is listed as a key threatening process. The proposal does not include any clearing of saltmarsh communities. Alteration of the natural flow regime of a river, stream or wetlands is also a key threatening process. At this stage, the flow regimes associated with the development have not been determined and so indirect impacts to isolated patches of saltmarsh (e.g. along Captain Cook Drive) are unknown, although they are likely to be minor at most.

**Conclusion**

It is unlikely that the coastal saltmarsh community EEC will be impacted by the proposal, directly or indirectly. Greater confidence in this assessment would follow further consideration of stormwater issues and construction techniques (which are not currently known).

It is noted that the landscape concept plan (**Appendix A**) indicates that there could be scope for creation of saltmarsh areas on the gentle slopes adjacent the mangroves on the western land. Saltmarsh recreation is difficult to achieve and depends on a suitable elevation, substrate, water chemistry etc. If saltmarsh is re-established in this area, this would increase the extent of saltmarsh in the vicinity.

A Species Impact Statement is not required for the proposal with respect to this community.

**The shorebird community occurring on the relict tidal delta sands at Taren Point**

The shorebird community occurring on the relict tidal delta sands at Taren Point, known hereafter as the Taren Point shorebird endangered ecological community (TPS EEC), stretches from Taren Point to Shelley Point, approximately 3 km north-west of the study site. The TPS EEC has been listed due to its unique assemblage of shorebirds, restricted habitat, and numerous threats that place pressure on shorebird species which make up the community.

The TPS EEC is a unique assemblage of shorebirds owing to the presence of the threatened terek sandpiper (*Xenus cinereus*). The greater abundance of smaller, mudflat feeding shorebirds such as red-necked stint (*Calidris ruficollis*), ruddy turnstone (*Arenaria interpres*), red knot (*Calidris canutus*), curlew sandpiper (*Calidris ferruginea*), Pacific golden plover (*Pluvialis fulva*) and grey tattler (*Heteroscelus brevipes*) also contribute to the uniqueness of the community (NSW DECC 2007a).

No habitat for the TPS EEC exists in the general vicinity of the proposed development site, as the community is located between Taren Point and Shelley Point, however the proximity of mangroves surrounding the site are important to species such as the terek sandpiper and grey-tailed tattler. The high invertebrate richness within Quibray Bay and surrounds are also important for foraging.

The majority of shorebirds that occur within the study area (including those listed within the TPS EEC) are migratory species and spend the breeding period in the northern hemisphere. The table below summarises the migratory movements and general species' requirements of shorebirds that utilise the study area.

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

The TPS EEC is not a threatened species.

**b) "In the case of an endangered population whether the life cycle 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".**

This is not an endangered population.

**c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

**i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

**ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Species from the TPS EEC have been known to forage in the mangroves both on and adjacent to the study site. There will be no removal of habitat or foraging grounds. However, birds that are part of the TPS EEC may be indirectly affected by increased traffic, human disturbances, lighting and noise.

Migratory shorebirds are known to be impacted by noise, light and tall buildings (URS 2003). Shorebirds tend to prefer sites that allow a clear view around feeding and roosting habitats and tend to

avoid regions enclosed by tall buildings (AMBS 2007; URS 2003). This has been termed the 'boxing-in effect'.

The height and scale of the proposed development may discourage the use of the estuary and mangrove areas by migratory species. However, as the species' primary residence is in a conservation reserve 3 km to the NW between Taren and Shelley Points, the effect of the proposed development is likely to be minor and should not place the EEC (or species within it) at risk of local extinction.

**d) in relation to the habitat of a threatened species, population or ecological community:**

**i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

**ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

**iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

No habitat will be removed as part of this project. As previously discussed, habitat in the immediate vicinity of the subject site may be temporarily or permanently modified by the development. These changes would be experienced in the mangroves of the channel and mangroves immediately to the north of the subject site. The extent of impact associated with a changed stormwater regime has not yet been determined.

**e. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),**

No areas of critical habitat occur on or adjacent to this site.

**f. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,**

Not required

**g. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

Relevant key threatening processes include:

- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments
- Alteration to the natural flow regimes of rivers, streams and their floodplains and wetlands

Birds within the TPS EEC include the sooty oystercatcher (*Haematopus fuliginosus*) and the pied oyster catcher (*H. longirostris*). Both of these species are vulnerable to becoming entangled or ingesting marine debris. Such impacts can leave the birds injured, reducing their ability to reproduce, catch prey and avoid predations. Entanglement and ingestion of waste material can also cause death. The proposed development is likely to see an increase in human generated waste in the region.

A comprehensive waste management plan is required as part of the project, including the installation of gross pollutant traps, community education, signage, and provision of fauna-proof bins in public areas.

Further assessment will be required to determine potential impacts of proposed changes to flow regimes once details from flood and water quality modelling become available.

**Conclusion**

The primary habitat of the TPS EEC will not be directly affected by the proposal. Mangrove habitat within 60 m of the subject site will be temporarily affected by construction noise, which may indirectly affect some species associated with the TPS EEC. Further information is needed determine if the EEC species would be indirectly affected by changes to stormwater management regimes.

**7 part tests for species listed under the TSC Act identified as being likely to frequent the subject site or surrounds**

| Species | In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction. | In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction | In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: | 'In relation to the habitat of a threatened species, population or ecological community:<br><br>The extent to which habitat is likely to be remove/ modified<br><br>Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat<br><br>The importance of the habitat to be removed etc to the long term survival of the species, | Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly), | Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan, | Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process |
|---|---|---|---|---|---|---|---|
| ***Calamanthus fuliginosus*** Striated fieldwren | The species mainly utilises saltmarsh communities, but may be an infrequent visitor and forager in mangroves.<br><br>No saltmarsh will be directly affected by the proposal. Mangrove habitat in the study area may be affected by noise and stormwater, although there is alternative habitat available in nearby areas and reserves.<br><br>The proposal is unlikely to affect the life cycle of this species because there is sufficient good quality habitat that would be unaffected by the proposal. | Not an endangered population. | Not an endangered EEC | It is unlikely that saltmarsh habitat will be removed or modified as part of this proposal.<br><br>Mangrove habitat in the vicinity of the subject site will be affected by noise and stormwater. Indirect impacts are likely to be focused within the channel and area immediately to the north of the subject site. These areas are not important habitat for the striated fieldwren and the survival of the species is unlikely to be affected.<br><br>Proposed landscaping may increase the area of saltmarsh habitat – subject to detailed design. | No critical habitat has been declared for this species. | No recovery plan has yet been developed for this species. No relevant threat abatement plans have been prepared for this species. | Relevant key threatening processes (KTP) are removal of native vegetation and changes to flow regimes.<br><br>Proposed revegetation will, on balance, increase the amount of native vegetation on the subject site.<br><br>Further detail of expected water quality and volumes associated with the proposed development would be needed to determine if there is likely to be an improvement, decline or virtually no change to habitat for this species. |
| ***Burhinus grallarius*** Bush stone-curlew<br><br>***Esacus neglectus*** Beach stone-curlew | These species are known to utilize mudflats near mangroves and occur in Towra Point wetlands. They may forage in mangroves adjacent to the subject site.<br><br>Mangrove habitat in the study area may be affected by noise and stormwater, although there is alternative habitat available in nearby areas and reserves.<br><br>The proposal is unlikely to affect the life cycle of this species because there is sufficient good quality habitat that would be unaffected by the proposal. | Not an endangered population | Species are not an endangered EEC | Mangrove habitat in the vicinity of the subject site will be affected by noise and stormwater. Indirect impacts are likely to be focused within the channel and area immediately to the north of the subject site.<br><br>These areas are not important habitat for these species and their survival is unlikely to be affected. | No critical habitat has been declared for this species. | No recovery plan has yet been developed for this species. No relevant threat abatement plans have been prepared for this species | Relevant KTPs are removal of native vegetation and changes to flow regimes.<br><br>No mangroves will be cleared for the proposed development.<br><br>Further detail of expected water quality and volumes associated with the proposed development would be needed to determine if there is likely to be an improvement, decline or virtually no change to habitat for these species. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Charadrius leschenaultia*** Greater sand plover<br><br>***Charadrius mongolus*** Lesser sand plover<br><br>***Haematopus fuliginosus*** Sooty oystercatcher*<br><br>***Haematopus longirostris*** Pied oystercatcher*<br><br>***Thinornis rubricollis*** Hooded plover<br><br>***Pandion haliaetus*** Osprey | These species mainly utilize mudflats and/or beaches, and have been recorded foraging in mangroves near the site.<br><br>Mangrove habitat in the study area may be affected by noise and stormwater, although there is alternative habitat available in nearby areas and reserves.<br><br>The proposal is unlikely to affect the life cycle of this species because there is sufficient good quality habitat that would be unaffected by the proposal. | Not an endangered population | Species are not an endangered EEC<br><br>*Species are associated with the TPS EEC | Mangrove habitat in the vicinity of the subject site will be affected by noise and stormwater. Indirect impacts are likely to be focused within the channel and area immediately to the north of the subject site.<br><br>These areas are not important habitat for these species and their survival is unlikely to be affected. | No critical habitat has been declared for this species | No recovery plan has been developed for these species.<br><br>No relevant threat abatement plans have been prepared for these species | Relevant KTPs are removal of native vegetation, changes to flow regimes and entanglement or ingestion of marine debris.<br><br>No mangroves will be cleared for the proposed development.<br><br>Further detail of expected water quality and volumes associated with the proposed development would be needed to determine if there is likely to be an improvement, decline or virtually no change to habitat for these species.<br><br>Entanglement or ingestion of marine debris is a KTP for these species. The subject site is currently affected by high levels of rubbish. Waste management measures required to deal with increased waste generation from the development include well maintained GPTs, regular rubbish removal, signage and community education. Future management should improve this situation and reduce the risk of this KTP. |
| ***Sterna albifrons*** Little tern | Open mudflats and sandflats in the study area provide foraging habitat for the little tern. There are known populations on the Kurnell peninsula at Boat Harbour.<br><br>This species is not likely to forage in mangroves and therefore is unlikely to be affected by the proposed development. | Not an endangered population | Species is not an endangered EEC | Habitat for this species is unlikely to be affected by the proposed development. | No critical habitat has been declared for this species | A recovery plan is current for this species. The proposed works are consistent with the objectives of this plan as they do not increase human exposure or impact habitat of the species. | Removal of native vegetation and changes to flow regimes are unlikely to affect this species.<br><br>Entanglement or ingestion of marine debris is a KTP for this species. The subject site is currently affected by high levels of rubbish. Waste management measures required to deal with increased waste generation from the development include well maintained GPTs, regular rubbish removal, signage and community education. Future management should improve this situation and reduce the risk of this KTP. |
| ***Xenus cinereus*** Terek sandpiper*<br><br>***Limicola falcinellus*** | Surrounding mud and sandflats, as well as mangroves provide foraging habitat for these species. The species have been recorded at Towra Point wetlands.<br><br>Mangrove habitat in the study area may be affected by noise and stormwater, although | Not an endangered population | Species are not an endangered EEC<br><br>*Species are associated with the TPS EEC | Mangrove habitat in the vicinity of the subject site will be affected by noise and stormwater. Indirect impacts are likely to be focused within the channel and area immediately to the north of the subject site.<br><br>These areas are not important habitat for | No critical habitat has been declared for this species | No recovery plan has yet been developed for this species. No relevant threat abatement plans have been prepared for this species | Relevant KTPs are removal of native vegetation and changes to flow regimes.<br><br>No mangroves will be cleared for the proposed development.<br><br>Further detail of expected water quality and |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Broad-billed sandpiper<br><br>***Calidris tenuirostris***<br>Great knot* | there is alternative habitat available in nearby areas and reserves.<br><br>The proposal is unlikely to affect the life cycle of these species because there is sufficient good quality habitat that would be unaffected by the proposal. | | | these species and their survival is unlikely to be affected. | | | volumes associated with the proposed development would be needed to determine if there is likely to be an improvement, decline or virtually no change to habitat for these species. |
| ***Pteropus poliocephalus***<br>Grey-headed flying-fox | Grey-headed flying fox has been recorded on the subject site or in the immediate surrounds. The vegetation within the study area provides potential foraging habitat. A colony of the species known to roost in the Kurnell peninsula.<br><br>Mangrove habitat in the study area may be affected by noise and stormwater, although there is alternative habitat available in nearby areas and reserves.<br><br>The proposal is unlikely to affect the life cycle of these species because there is sufficient good quality habitat that would be unaffected by the proposal. | Not an endangered population | Not an endangered EEC | Mangrove habitat in the vicinity of the subject site will be affected by noise and stormwater. Indirect impacts are likely to be focused within the channel and area immediately to the north of the subject site.<br><br>These areas are not important habitat for these species and their survival is unlikely to be affected. | No critical habitat has been declared for this species | There is a draft national recovery plan for this species. The proposed works meet the objectives of this plan. | Relevant KTPs are removal of native vegetation and changes to flow regimes.<br><br>No mangroves will be cleared for the proposed development.<br><br>Further detail of expected water quality and volumes associated with the proposed development would be needed to determine if there is likely to be an improvement, decline or virtually no change to habitat for these species. |

# Appendix F: Flora

**The following table lists all flora species recorded within the study area from available records.**

Key to conservation status symbols used in flora and fauna species inventories

| Key to symbols | |
|---|---|
| + | Introduced species |
| N (Wx) | Noxious weed listed under the *NSW Noxious Weeds Act 1993* (see Box 1) |
| P | Planted specimen |
| Ni | non-indigenous native species (Australian in origin, but not indigenous to this locality) |
| E or V | TSC Act listed an endangered species or as vulnerable species |
| E(C) or V(C) | Endangered or Vulnerable - listed under the EPBC Act (Commonwealth) |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| **Agavaceae** | | |
| *Yucca aloifolia* | Yucca | + |
| **Aizoaceae** | | |
| *Carpobrotus glaucescens* | Pig Face | P |
| *Tetragonia letragonioides* | New Zealand Spinach | + |
| Amaryllidaceae | | |
| *Agapanthus praecox* | Agapanthus | +P |
| **Apiaceae** | | |
| *Centella asiatica* | Swamp Pennywort | + |
| *Foeniculum vulgare* | Fennel | + |
| *Hydrocotyle bonariensis* | Kurnell Curse | + |
| *Hydrocotyle penuncularis* | | + |
| **Araceae** | | |
| *Philodendron selloum* | Philodendron | + P |
| **Araliaceae** | | |
| *Schefflera actinophylla* | Umbrella Tree | + P |
| **Araucariaceae** | | |
| *Araucaria heterophylla* | Nolfolk Island Pine | Ni P |
| **Arecaceae** | | |
| *Howea forsteriana* | Kentia Palm | Ni P |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| *Syagrus romanzoffanum* | Cocos Palm | + P |
| *Washingtonia filifera* | Fringe Palm | + P |
| **Asclepiadaceae** | | |
| *Araujia hortorum* | Mothvine | + |
| **Asparagaceae** | | |
| *Myrsiphyllum asparagoides* | Bridal Veil Creeper | |
| *Protasparagus aethiopicus* | Asparagus Fem | + |
| **Asteraceae** | | |
| *Ageratino adenophora* | Crofton Weed | + |
| *Bidens pilosa* | Cobbler's Pegs | + |
| *Chrysamthemoides monilifera* ssp *rotundata* | Bitou Bush | + N (4) |
| *Cirsium vulgare* | Spear Thistle | + |
| *Conyza albida* | Tall Fleabane | + |
| *Conyza bonariensis* | Flax-leaf Fleabane | + |
| *Conyza canadensis* ssp *canadensis* | Canadian Fleabane | + |
| *Coreopsis lanceolata* | Coreopsis | + |
| *Cotula coronopifolia* | Waterbuttons | + |
| *Erigeron karvinskianus* | Coastal Daisy | + P (?) |
| *Hypochaeris radicata* | Cats Ears | + |
| *Senecio madagascariensis* | Fireweed | + |
| *Sonchus oleraceus* | Common Sowthistle | + |
| *Tagetes minuta* | Stinking Roger | + |
| **Avicenniceae** | | |
| *Avicennia marina subsp. austalasica* | Grey Mangrove | |
| **Basellaceae** | | |
| *Anredera cordifolia* | Madeira Vine | + |
| **Boraginaceae** | | |
| *Baraga officinalis* | Borage | + |
| **Brassicaceae** | | |
| *Brassica rapa* | Wild Turnip | + |
| *Brassica lournefotii* | Mediterranean Turnip | + |
| *Capsella bursapastoris* | Shepherds purse | + |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| Raphanus *raphanistrum* | Wild Radish | + |
| **Buxaceae** | | |
| *Buxus micraphylla var.japonica* | Japanese Box | + P |
| *Buxus sempervirens* | English Box | + P |
| **Caryophyllaceae** | | |
| *Slellaria media* | Chickweed | + |
| **Casuarinaceae** | | |
| *Casuarina cunninghamia* | River She-Oak | P |
| *Casuarina glauca* | Swamp Oak | |
| **Chenopodiaceae** | | |
| *Sarcocornia quinqueflora* | Samphire | *P* |
| *Suaeda australis* | Austral Seablite | P (?) |
| **Commelinaceae** | | |
| *Commelina cyanea* | Scurvy Weed | + |
| *Tradescanthia albiflora* | Wandering Jew | + |
| **Convolvulaceae** | | |
| *Dichondra repens* | Kidney Weed | |
| *Ipomoea indica* | Morning Glory | + |
| **Cyperaceae** | | |
| *Cyperus brevifolills* | Mullumbimby Couch | *Ni* |
| *Isoepis ladasa* | Nobby Clubrush | |
| **Doryanthaceae** | | |
| *Doryanthes excelsa* | Gymea Lily | *P* |
| **Euphorhiaceae** | | |
| *Breynia oblongyafia* | Coffee Bush | + |
| *Euphorbia peptus* | Petty Spurge | + |
| *Glochidion ferdinandi var ferndinandi* | Cheese Tree | + |
| *Omalanthus nutans* ssp *nutans* | Native Bleeding Heart | + |
| *Ricinus communis* | Castor Oil Plant | *+N(4)* |
| **Fabaceae (Caesalpinioideae)** | | |
| *Senna pedula* var *glabrata* | Winter Senna | + |
| **Fabaceae (Faboideae)** | | |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| *Erythrina sp* | Coral Tree | + |
| *Glycine clandestina* | Love Creeper | + |
| *Trifolium repens* | White clover | + |
| *Trifolium campestre* | Hop Clover | + |
| *Vicia tetrasperma* | Slender Vetch | + |
| **Fabaceae (Mimosoideae)** | | |
| *Acacia linifolia* | Flax-leaved Wattle | P |
| *Acacia longifolia* subsp. *longifolia* | Sydney Golden Wattle | P & native |
| *Acacia longifolia* subsp *sophorae* | Coastal Wattle | P |
| *Acacia parramallensis* | Parramatta Green Wattle | P |
| **Fumariaceae** | | |
| *Fumaria muralis* | Wall Fumitory | + |
| **Iridaceae** | | |
| *Ixia maculata* | Ixia | + |
| **Juncaceae** | | |
| *Juncus krausii* var *australasica* | Sea Rush | |
| **Laminceae** | | |
| *Westringia fruticosa* | Coastal Westringia | P |
| *Westringia longifolia* | - | P |
| **Lauraceae** | | |
| *Cinnamomum camphora* | Camphor Laurel | + |
| **Lomandraceae** | | |
| *Lomandra longifolia* | Spiny headed Mat Rush | P |
| **Malyaceae** | | |
| *Hibiscus rosa-sinensis* | Chinese Hibiscus | +P |
| *Lagunaria patersonii* | Norfolk Island Hibiscus | +P |
| *Sida rhombifolia* | Paddy's Lucerne | + |
| **Malvaceae** | | |
| *Brachychiton acerifolius* | Illawarra Flame tree | P |
| **Moraceae** | | |
| *Ficus microphylla var hillii* | Hill's Weeping Fig | P |
| *Ficus rubiginosa* | Port Jackson Fig | P |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| **Myrtaceae** | | |
| *Callistemon citrinus cvs* | Crimson Bottlebrush | Ni P |
| *Callistemon salignus* | Willow Bottlebrush | P |
| *Callistemon viminalis* cvs | Weeping Bottlebrush | P |
| *Corymbia gummifera* | Red Bloodwood | P |
| *Eucalyptus gomphocephala* | Tuart | Ni P |
| *Eucalyptus leucoxylan* | Yellow Gum | Ni P |
| *Eucalyptus microcorys* | Tallowood | Ni P |
| *Eucalyptus resinifera* | Red Mahogany | P |
| *Eucalyptus robusta* | Swamp Mahogany | P |
| *Eucalyptus scoparia* | Wallangarra White Gum | Ni E V (C) P |
| *Eucalyptus teriticornis* | Forest red gum | P |
| *Eucalyptus viminalis* | Ribbon Gum | Ni P |
| *Kunzea ambigua* | Tick Bush | Ni P |
| *Leptospermum laevigatum* | Coast tea-tree | Ni P |
| *Lophostemon confertus* | Brush Box | Ni P |
| *Leptospermum petersonii ssp petersonii* | Lemon-scented Tea-tree | Ni P |
| *Melalecua armillaris* | Bracelet Honeymyrtle | Ni P |
| *Melaleuca ericifolia* | Swamp Paperbark | |
| *Melaleuca hypericifolia* | - | P |
| *Melaleuca linariifolia* | Snow-in-summer | P |
| *Metrosideros excels* | Pohutakawa | +P |
| *Syzygium paniculaum* | Magenta Lillypilly | V V (C) P |
| **Nyctaginacae** | | |
| *Bougainvillea sp* | Bougainvilla | +P |
| **Oleaceae** | | |
| *Olea europaea subsp. africana* | African Olive | +N(4) |
| **Oxalidaceae** | | |
| *Oxalis corniculata var repens* | Creeping Oxalis | + |
| **Phormiaceae** | | |
| *Phorium tenax* | New Zealand Flax | +P |
| **Pittosporaceac** | | |
| *Pittosportum undulaum* | Sweet Pittosporum | + |
| **Plantaginaceae** | | |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| *Plantago lanceolata* | Plantain | + |
| **Poaceae** | | |
| *Agrostis avenacea* | Blown Grass | |
| *Andropogon virginicus* | Whisky Grass | + |
| *Arundo donax* | Giant Reed | + |
| *Avena fatua* | Wild Oats | + |
| *Briza maxima* | Quaking Grass | + |
| *Bromus catharticus* | Soft Broome | + |
| *Coriaderia selloana* | Pampas Grass | +N(3) |
| *Cynodon dactylon* | Counch Grass | +P |
| *Digitaria sanguinalis* | Summer Grass | + |
| *Ehrharia erecta* | Panic Veldt Grass | + |
| *Entolasia marginata* | Bordered Panic | |
| *Entolasia stricia* | Wiry Panic | |
| *Eragrostis curvula* | African Love Grass | + |
| *Imperata cylindrical var major* | Blady Grass | |
| *Microlaena stipoides var stipoides* | Meadow Rice Grass | |
| *Paspalum dilatatum* | Paspalum | + |
| *Pennisetum clandestinum* | Kikuya | +P |
| *Phragmites Australia* | Native Reed | |
| *Setaria pumila* | Pigeon Grass | + |
| *Sporobolus indicus var capensis* | Parramatta Grass | + |
| *Stenotaphrum secundatum* | Buffalo Grass | + |
| *Themeda asutralia* | Kangaroo Grass | P |
| **Polygonaceae** | | |
| *Acetosa sagittata* | Turkey Rhubarb | + |
| *Rumex crispus* | Curled Dock | + |
| **Proteaceae** | | |
| *Banksia integrifolia* | Coastal Banksia | P |
| *Banksia serrata* | Old Man Banksia | P |
| *Banksia oblongifolia* | Banskia | P |
| **Grevillea** | | |
| *Grevillia rosmarinifolia* | | P |
| **Rosacea** | | |
| *Photinia glabra Lutescens* | Photinia | + |
| *Robus fruticosus* species aggregate | Blackberry | + |
| **Rutaceae** | | |
| *Coleonema pulchrum* | Colenema | +P |
| *Murraya paniculatata* | Murraya | +P |

| SCIENTIFIC NAME | COMMON NAME | CONSERVATION STATUS |
|---|---|---|
| **Scrophulariaceae** | | |
| *Hebe diosmifolia* | Hebe | +P |
| **Solanacea** | | |
| *Cestrum parqui* | Green Cestrum | +N(3) |
| *Solanum mauritianum* | Wild Tobacco | + |
| *Solanum nigram* | Blackberry Nightshade | + |
| *Solanum americanum* | Glossy Nightshade | + |
| **Urticaceae** | | |
| *Parietaria judaica* | Pellitory | +N(4) |
| **Verbenacea** | | |
| *Lantana camara* | Lantana | +N(4) |
| *Verbena bonariensis* | Purple top | + |
| *Verbena rigida* | Veined Verbena | + |
| *Verbena officinalis* | Common verbena | + |
| Vitaceae | | |
| *Vitex prupurea* | Vitex | +P |
| *Hedychium gardnerianum* | Wild Ginger | + |

# Appendix G: Fauna

Table of fauna species recorded in the vicinity of the site either during current investigations or during previous studies.

| TAXA | FAMILY | SCIENTIFIC NAME | COMMON NAME |
|---|---|---|---|
| Reptiles | Scincidae | *Lampropholis spp.* | Skink |
| | | | |
| Mammals | Phalangeridae | *Trichosurus vulpecula* | Common brushtail possum |
| | Canidae | *Vulpes vulpes* | European red fox* |
| | Pteropodidae | *Pteropus poliocephalus* | Grey-headed flying fox[+] |
| | Vespertilionidae | *Vespadelus vulturnus* | Little forest bat |
| | Felidae | *Felis domesticus* | Domestic cat |
| | | | |
| Birds | Phalacrocoracidae | *Phalacrocorax varius* | Pied cormorant |
| | | *Phalacrocorax sulcirostris* | Little black cormorant |
| | Pelecanidae | *Pelecanus conspicillatus* | Australian pelican |
| | Ardeidae | *Ardea alba* | Great egret[#] |
| | | *Egretta novaehollandiae* | White-faced heron |
| | Threskiornithedae | *Plegadis facinellus* | Australian white ibis |
| | | *Platalea regia* | Royal spoonbill |
| | Scolopacidae | *Limosa lapponica* | Bar-tailed godwit[#+] |
| | | *Numenius madagascariensis* | Eastern curlew[#+] |
| | Charadriidae | *Vanellus miles* | Masked lapwing |
| | Laridae | *Larus novachollandiae* | Silver gull |
| | Columbidae | *Streptopelia chinensis* | Spotted turtledove* |
| | | *Ocyphaps lophotes* | Crested pigeon |
| | Cacatuidae | *Cacatua galerita* | Sulphur-crested cockatoo |
| | Psittacidae | *Trichoglossus haematodus* | Rainbow lorikeet |
| | | *Psephotus haematonotus* | Red-rumped parrot |
| | Halcyonidae | *Dacelo novaeguineae* | Laughing kookaburra |
| | Maluridae | *Malurus cyaneus* | Superb fairywren# |
| | Pardalotidae | *Acanthiza spp.* | Thornbill |
| | Meliphagidae | *Anthochaera chrysoptera* | Brush wattlebird |
| | | *Anthochaera carnunculata* | Red wattlebird |
| | | *Manorina melanocephala* | Noisy miner |
| | | *Lichenostomus penicillatus* | White-plumed honeyeater |
| | | *Lichmera indistincta* | Brown honeyeater |

| TAXA | FAMILY | SCIENTIFIC NAME | COMMON NAME |
|---|---|---|---|
| | Petroicidae | *Microeca fascinans* | Jacky winter |
| | Pachycephalidae | *Pachycephala lanioides* | Rufous whistler |
| | Dicruridae | *Grallina cyanoleuca* | Australian magpie-lark |
| | | *Rhipidura leucophrys* | Willie wagtail |
| | Artamidae | *Cracticus torquatus* | Grey butcherbird |
| | | *Gymnorhina tibicens* | Australian magpie |
| | | *Strepera graculina* | Pied currawong |
| | Corvidae | *Corvus coronoides* | Australian raven |
| | Sturnidae | *Sturnus vulgaris* | Common starling* |
| | | *Acridotheres tristis* | Common myna* |
| | Hirundinidae | *Hirundo neoxena* | Welcome swallow |

*indicates an introduced species, + = Species listed as Vulnerable or EEC species (TSC Act), # = Migratory species (EPBC Act, 1999)

# Appendix H: Shadow drawings

PRELIMINARY

**PROPOSED SCHEME - 21 JUNE (WINTER)**


1 SHADOW DIAGRAM EXISTING - 21 JUNE 9AM
1 : 4000


2 SHADOW DIAGRAM EXISTING - 21 JUNE 12PM
1 : 4000


3 SHADOW DIAGRAM EXISTING - 21 JUNE 3PM
1 : 4000

**PROPOSED SCHEME - 21 JUNE (WINTER)**


4 SHADOW DIAGRAM - 21 JUNE 9AM.
1 : 4000


5 SHADOW DIAGRAM - 21 JUNE 12PM.
1 : 4000


6 SHADOW DIAGRAM - 21 JUNE 3PM
1 : 4000

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1 : 4000 @ A1

SHADOW DIAGRAMS - JUNE 21

20100176 A501 1

PRELIMINARY

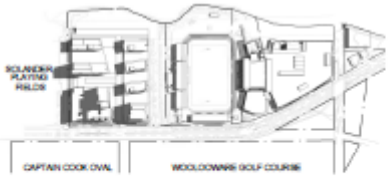
**PROPOSED SCHEME - 21 DECEMBER (SUMMER)**


SHADOW DIAGRAM
① EXISTING - 21 DEC 9AM
1 : 4000


SHADOW DIAGRAM
② EXISTING - 21 DEC 12PM
1 : 4000

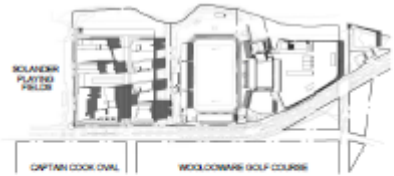

SHADOW DIAGRAM
③ EXISTING - 21 DEC 3PM
1 : 4000

**PROPOSED SCHEME - 21 DECEMBER (SUMMER)**




SHADOW DIAGRAM - 21
④ DEC 9AM
1 : 4000


SHADOW DIAGRAM - 21
⑤ DEC 12PM
1 : 4000




SHADOW DIAGRAM - 21
⑥ DEC 3PM
1 : 4000

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1 : 4000 @ A1

SHADOW DIAGRAMS - DEC 21

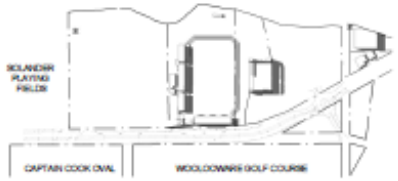
20100176 A502 1

PRELIMINARY

PROPOSED SCHEME - EQUINOX (21 MARCH & 21 SEPTEMBER)

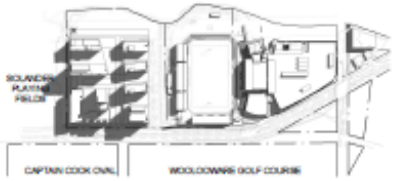

1 SHADOW DIAGRAM EXISTING - 21 MAR 9AM
1 : 4000


2 SHADOW DIAGRAM EXISTING - 21 MAR 12PM
1 : 4000




3 SHADOW DIAGRAM EXISTING - 21 MAR 3PM
1 : 4000

PROPOSED SCHEME - EQUINOX (21 MARCH & 21 SEPTEMBER)




4 SHADOW DIAGRAM - 21 MAR 9AM
1 : 4000


5 SHADOW DIAGRAM - 21 MAR 12PM
1 : 4000


6 SHADOW DIAGRAM - 21 MAR 3PM
1 : 4000

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1 : 4000 @ A1

SHADOW DIAGRAMS - EQUINOX

20100176 A503 1

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