Attachment 3 - Assessment of Potential Impacts on the Ecological Character of the Moreton Bay Ramsar Wetland from the Toondah Harbour Project

Introduction

It is recognised that the proposed Toondah Harbour development has the potential to have a significant impact on the Moreton Bay Ramsar Wetland and is therefore referred as a controlled action warranting further assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). To assist proponents determine if their proposed action is likely to have a significant impact on matters of national environmental significance (MNES), the Commonwealth Government produced a series of guidelines on significant impacts. Most relevant for Ramsar wetlands are the *Significant Impact Guidelines 1.1 Matters of National Environmental Significance* (CoA 2013). These guidelines state that:

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance.

The guidelines goes on to identify specific significant impact criteria for each MNES. An action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:

- areas of the wetland being destroyed or substantially modified;
- a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland;
- the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected;
- a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health; or
- an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.

While the Significant Impact Guidelines provide some guidance on how to assess impacts to a Ramsar Wetland, the criteria are broad and difficult to apply at a site level to large and ecologically diverse wetlands. The Moreton Bay Ramsar Wetland covers an area of approximately 113,314 ha and contains a wide range of ecosystems ranging from perched freshwater lakes and sedge swamps on the offshore sand islands, to intertidal mudflats, marshes, sandflats and mangroves next to the Bay's islands and the mainland.

This assessment provides a methodology for identifying the ecological character at the whole of wetland and local scales and assessing significant impacts to the Moreton Bay Ramsar Wetland at the site level. A preliminary assessment of the Toondah Harbour Project against that methodology has also been carried out to identify potential for significant impacts to occur.

Methodology

The significant impact assessment methodology has been developed by Adaptive Strategies to assess potential impacts to the ecological character of the Moreton Bay Wetland. The method is adapted from previously accepted approach developed for the Great Barrier Reef World Heritage Area (Adaptive Strategies 2016), which while protected under a different international convention has many similarities in terms of scale, ecological process and protection. The methodology also incorporates aspects of the *National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Wetlands,* although it focusses on physical components of the wetland and does not include ecological processes or benefits which will be assessed through the EIS process.

The method comprises two components:

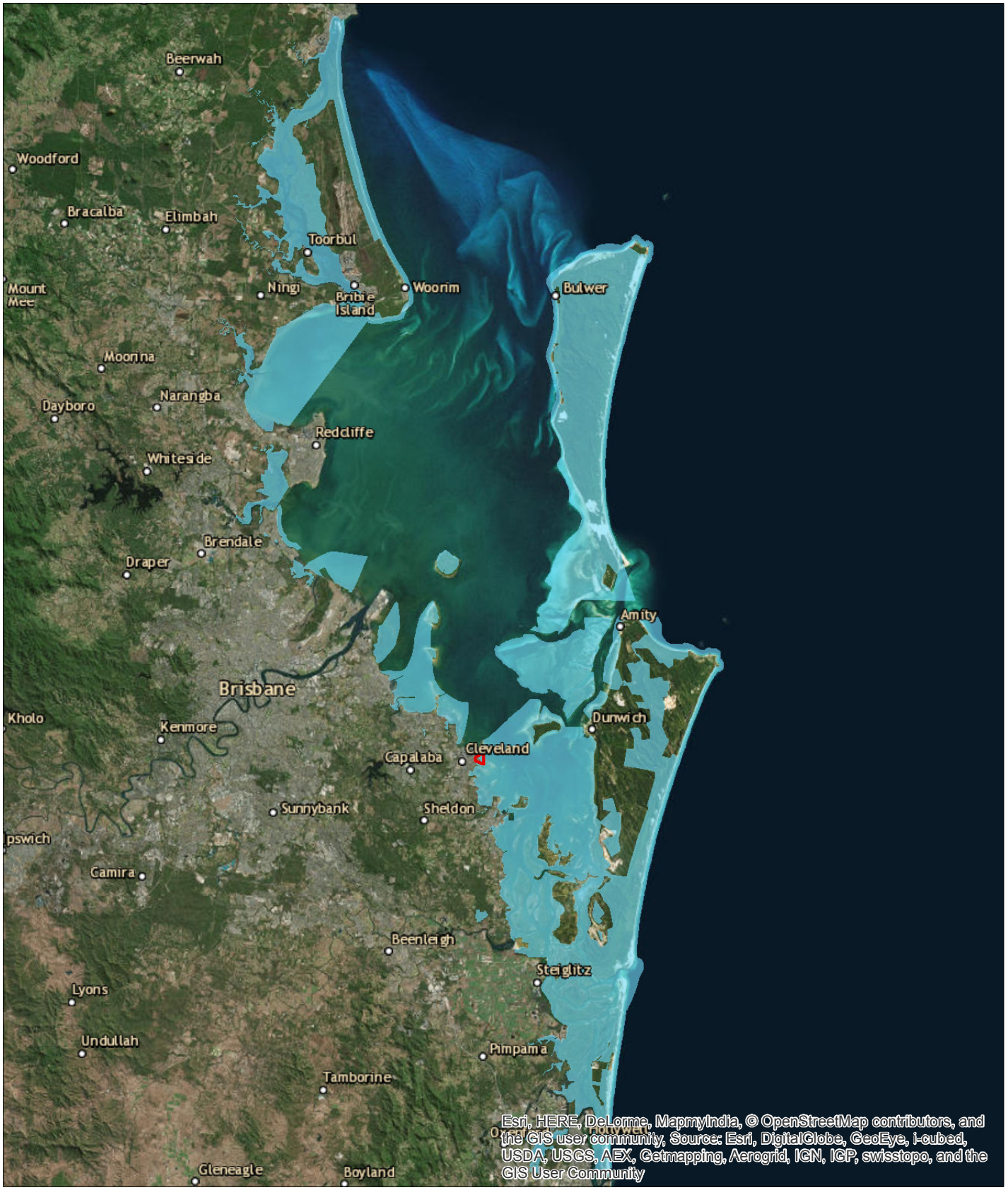
1. Contextual information about ecological character to provide a framework for the analysis; and
2. A process to be applied at the local scale.

The methodology including the rationale behind its development is attached to this technical note with the key components summarised within this assessment.

Moreton Bay Ramsar Wetland Contextual Information

The Criteria for Identifying Wetlands of International Importance were adopted by the 7th (1999) and 9th (2005) Meetings of the Conference of the Contracting Parties, superseding earlier Criteria adopted by the 4th and 6th Meetings of the COP (1990 and 1996), to guide implementation of Article 2.1 on designation of Ramsar wetlands.

Moreton Bay is listed as a Ramsar site as it fulfils six of the nine criteria for identifying wetlands of international importance. The criteria and key environmental values supported by Moreton Bay for each criterion is provided in **Table 1**. The extent of the Moreton Bay Ramsar Wetland is shown on **Figure 1**.



Legend

PDA - Toondah Harbour

Moreton Bay RAMSAR wetland

Figure 1 *Moreton Bay Ramsar Wetland*

File ref. 8444 E Site Context A
Date *20/04/2017*
Project *Toondah Harbour*

0 5 10 20 *Kilometers*

N

Scale (A4): 1:575,379 [GDA 1994 MGA Z56]

saunders havill group

Layer Sources QLD GIS Layers (QLD Gov. Information Service 2014)

Table 1: Summary of Moreton Bay key environmental values against Ramsar listing criterion (EPA 1999)

Criterion description	Moreton Bay key values
Criterion 1: the wetland contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region	Moreton Bay is one of the largest estuarine bays in Australia. The formation of large vegetated sand dunes on the eastern side of the Bay and river and creek flows entering the Bay to the west from the mainland have created a major wetland complex.
Criterion 2: the wetland supports vulnerable, endangered or critically endangered species or threatened ecological communities	The Bay supports threatened turtle species including the vulnerable green (*Chelonia mydas)* and hawksbill turtles (*Eretmochelys imbricata*) and endangered loggerhead turtles (*Caretta caretta*). The area is particularly important for the critically endangered wintering eastern curlew (*Numenius madagascariensis*). A number of threatened terrestrial flora and fauna are also present on the islands.
Criterion 3: the wetland supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region	The Bay has a high diversity of marine plant and animal species including: over 355 species of marine invertebrates; 40 species of shorebirds; 55 species of algae associated with mangroves; seven mangrove species and seven seagrass species. The intertidal habitats of the Bay support over 30 species of migratory shorebirds.
Criterion 4: the wetland supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions	The Bay is a significant feeding ground for green turtles. Dugongs also use the area as a feeding and breeding ground. The area provides significant feeding areas for loggerhead turtles. The species is also known to nest on the islands of the Bay.
Criterion 5: the wetland regularly supports 20,000 or more waterbirds	The Bay supports greater than 50,000 wintering and staging shorebirds during the non-breeding season.
Criterion 6: the wetland regularly supports 1% of the individuals in a population of one species or subspecies of waterbird	The Bay supports greater than 1% of the known flyway populations of the eastern curlew (*Numensis madagascariensis)* and the grey-tailed tattler (*Tringa brevipes*).

An ecological character description is still in preparation for Moreton Bay Ramsar wetlands (DoEE 2017a). In the absence of a formal ecological character description for the site, this report has defined the ecological character of the Moreton Bay Ramsar wetland to be those key environmental values that contribute to the listing criteria of the site.

The Australian and Queensland governments have described the values of the wetland in various information documents including Moreton Bay — a wetland of international importance fact sheet and the Ramsar Information Sheet (RIS). These documents have been used to identify the key environmental features of the Moreton Bay wetland, which are listed below:

- One of the largest estuarine bays in Australia and sits in an 'overlap zone' where both tropical and temperate species occur. It supports extensive intertidal areas of seagrass, mangroves and saltmarsh that provide vital habitat for waterbirds, including significant populations of migratory shorebirds.
- Outstanding coastal wetland values and features. Many of its diverse habitat types retain a near-natural character and are interconnected with other habitats supporting biodiversity.
- Home to five nationally threatened plant species that are wetland dependant, such as the endangered swamp daisy, *Olearia hygrophila*, which is only found on North Stradbroke Island.
- Habitat for humpback whales and dolphins, as well as six of the world's seven species of marine turtles. Other threatened animals, including the grey nurse shark, dugong, wallum sedge frog, water mouse and Oxleyan pygmy perch fish, also live in the Bay or in surrounding waters and wetlands.
- A wetland habitat providing feeding areas, dispersal and migratory pathways, and spawning sites for many fish species. The region supports one of the most productive fisheries in Queensland.
- The perched wetlands on Moreton and North Stradbroke Islands, including lakes and swamps. Perched wetlands are abundant in the coastal Wallum regions of south-eastern Queensland and northern New

South Wales, but are scarce in most parts of the world. Perched wetlands form in depressions between dunes where impermeable layers develop in the sand and act like basins holding water higher in the landscape than the water table. They support many unique and interesting animals.

- One of the most important migratory shorebird sites in Australia, supporting both a large number and high diversity. During the summer months some 32 species of migratory shorebirds comprising over 40,000 individuals visit the Bay. This includes significant worldwide populations, including 20% of all eastern curlews and 50% of all grey-tailed tattlers.

Based on this description a number of key attributes have been identified for the Ramsar Wetland. The attributes are listed in **Table 2** and have been categorised according to the environmental features listed above. The attributes identified are all physical aspects of the environment such as seagrass beds, listed migratory shorebird species and perched sand lakes. Physical attributes were utilised as impacts to these features can be quantified and an assessment made on whether those impacts are considered a significant impact on the ecological character of the wetland.

It is acknowledged that impacts to ecological processes and services such as the tidal flows and sedimentation also have the potential to impact on the character of the wetland, although ultimate impacts from any changes to these processes would also be assessed through loss of the physical attributes (i.e. changes in tidal patterns may result in erosion of mud flats). These impacts would occur up and down stream of the development foot print and will be assessed through detailed hydrodynamic modelling carried out as part of the controlled action assessment process. If significant impacts outside of the footprint are identified the development footprint will be modified to mitigate these impacts.

Table 1: Key attributes of Moreton Bay Ramsar wetland

Environmental Feature	Attribute
Estuarine/Intertidal areas	Open beaches
	Seagrass
	Salt and mud flats, salt marshes
	Mangroves and related tree communities
	Rocky reefs
	Sand shoals
Coastal and sub-coastal vegetation	Tree swamp—Melaleuca spp. and Eucalyptus spp.
	Wet heath swamp
	Grass, sedge and herb swamp
Migratory shorebirds	Eastern curlew habitat (known)
	Grey tailed tattler habitat (known)
	Shorebird feeding areas (intertidal areas, beaches etc.)
	Shorebird roosting sites (above high water mark)

Environmental Feature	Attribute
Threatened plant species	*Olearia hygrophila* habitat
	Phaius australis habitat
	Phaius bernaysii habitat
	Thesium austral habitat
	Cryptocarya foetida habitat
	Other (specify)
Marine fauna habitat	Humpback whales
	Dolphins
	Marine turtles
	Dugong
	Grey nurse shark
	Wallum sedge frog
	Water mouse
Fish	Protected Fish Habitat Areas
	Oxleyan pygmy perch habitat
Lakes and enclosed water bodies	Window sand lakes
	Perched sand lakes
	Artificial water body habitats (dams, ring tanks etc.)

Local Scale Assessment

The process for determining the local representation and contribution of a feature to the ecological character of the wetland is based around understanding which attributes are present and how important those attributes are within the context of the wider wetland ecosystem. The process involves:

1. Identification of the attributes that occur within the local area (or surrounds)
2. Analysis of the 'importance' of the presence of those attributes within the context of the broader wetland.

In other words "what" and "where" are attributes located and "why" are they important in the context of the Ramsar listing?

Identification of attributes

Identification of the attributes that occur within the local area (or surrounds) should be based on the best available information including desktop (Government databases, regional level studies, etc) and site specific ecological surveys. Preliminary Terrestrial (BAAM 2017 – Attachment 6 to this referral) and Aquatic (FRC 2017 – Attachment 7 to this referral) ecological studies have been carried out for the site including desktop assessment and field survey within and adjacent to the PDA. Specific investigations relevant to the Ramsar wetland include:

- Benthic habitat survey within and adjacent to the PDA;
- Migratory shorebird surveys including five summer and one winter survey carried out between October 2014 and June 2015;
- Review of 20 years of high tide surveys conducted by the Queensland Wader Study Group at a high tide roost site to the south of the PDA (Nandeebie Claypan);
- On ground confirmation of remnant vegetation communities and mangrove and intertidal vegetation; and
- Assessment of the likelihood of protected marine and intertidal flora and fauna utilising the site.

The technical reports and summaries detailing the outcomes of the assessment are provided in response to sections 2.4 and 2.5 of the referral (refer to **Attachments 5 and 6** to the referral).

An analysis of the presence of the attributes was carried out based on the outcomes of the terrestrial and aquatic ecological assessment. Presence was attributed to one of the following categories:

- Not present: No evidence was available to indicate or suggest that the attribute is present at or near the location.
- Minor presence: These attributes occur in low abundance or across a small area (relative to the nature of the attributes broader presence across the wetland). Noting that a low abundant attribute that is rare may still be important. Temporary fluctuations or seasonal variation should be considered along with natural events that may affect short-term presence (e.g. storms). Example of low abundance might include:
  - Small isolated natural ecosystems (coral, vegetation communities etc.) of less than 10 hectares
  - Small number of non-breeding species (turtles, dolphins dugong etc.) that are foraging in the area
  - Individual occurrences of natural features (rocks, mangroves) that are not unique or notable in some manner.
- Moderate presence: These attributes occur in moderate abundance or across a moderately large area (relative to the nature of the attribute across the wetland). Examples may include:
  - Migratory shorebird aggregations of less than 0.1% of flyway population
  - Endangered ecosystems and habitats of 20-100 hectares
  - Minor nesting sites for common birds species (e.g. with small numbers of nesting individuals <10).
- Significant presence: These attributes are present in significant abundances or represent significant examples of the relevant attribute (relative to the nature of the attribute across the wetland). Examples:
  - Extensive continuous seagrass areas
  - Undisturbed natural vegetation
  - Migratory bird aggregations
  - 18 Mile Swamp (North Stradbroke Island).

Contribution to ecological character

The specific attributes of Moreton Bay are inconsistently spread across the whole Ramsar site with some more numerous than others. If an attribute was identified as being present within the PDA or in an area that could

potentially be impacted by the Toondah Harbour development further assessment was carried out to identify how much it contributes to the ecological character of Moreton Bay.

A particular attribute may be present in a particular location and may well be of importance due to its locally high value in terms of representation, appreciation or biological contribution; while in another area it may be a lower value as it does not provide the same ecological function (e.g. recruitment and breeding), representation of value or amenity. The influences of human appreciation, geography, climatic distribution, geology, oceanography and ecological life cycles all influence where and at what level a particular attribute may contribute to ecological character.

Contribution to the character of Moreton Bay was attributed to one of the following categories:

- Minor contribution: The attribute is present however it occurs in low abundance or singularly and is not:
  - essential to the sustainability of the attribute (e.g. substantial breeding or flyway population)
  - recognised as a key feature of the Moreton Bay Ramsar wetland (e.g. seagrass meadow)
  - iconic, unique or a high quality example of the attribute.
- Moderate contribution: These attributes occur in moderate abundance or across a moderately large area but are not the prime occurrence or representation of the attribute within the wetland. The attribute does however represent a feature for which the wetland was listed as a Ramsar site.
- Significant contribution: These attributes represent locally important examples of the attribute relative to the nature of the attribute across the wetland. Such an attribute may be specifically referred to within the RIS or defined by other legislation, planning instrument or values assessment (e.g. MNES). The occurrence of the attribute locally is a prime example of the attribute.

Assessment of presence of an attribute and its contribution to the ecological character of the Moreton Bay Ramsar Wetland is provided in **Table 3**. As noted the assessment is based on site specific studies carried out by BAAM and FRC Environmental (Refer to **Attachments 5 and 6**) to the EPBC Referral. Impacts have been assessed for the development footprint and adjacent high value areas such as the high tide roost sites. As previously noted impacts up and down stream of the development will be addressed in detail as part of the controlled action assessment process and once hydrodynamic modelling has been completed.

Table 3: Attribute presence and assessment of contribution to the ecological character of the Moreton Bay Wetland

Environmental Feature	Site Description	Attribute	Presence of Attribute	Contribution to Ecological Character
Estuarine/Intertidal areas	There are approximately 32.7 ha of seagrass within the PDA. The seagrass meadows are predominantly in the intertidal and shallow subtidal zone between the foreshore and Cassim Island, the island of mangroves offshore adjacent to the Toondah Harbour PDA. Moreton Bay supports 189 km^2 of seagrass. The largest and most dense seagrass meadows are in the eastern bay surrounding South Passage between Moreton and Stradbroke islands; though there are also substantial meadows in the southern and western parts of the bay. With increasing urbanisation and industrial development, seagrass meadows within western Moreton Bay have been lost over the past decades. While some meadows have been lost as a direct result of infilling, a far greater area of seagrass has been lost as a result of changes in water quality. There are approximately 1.2 ha of saltmarsh south of (and none within) the PDA. The saltmarsh is in the upper most intertidal zone with the mangroves offshore. The saltmarsh is highly disturbed by the developed areas along the foreshore. Within Moreton Bay, there is approximately 2,034 ha of saltmarsh habitat. The eastern side of Moreton Bay is typically dominated by the rush *Juncus kraussii* due to abundant freshwater in the intertidal zone, while the western side of Moreton Bay is dominated by chenopod species of Sarcocornia and Suaeda due to the hypersaline intertidal sand flats. There are approximately 5.3 ha of mangroves within the PDA. The mangrove forests are along the upper intertidal zone and are bordered by mud and sand flats. The mangrove forests along the foreshore are highly disturbed by the developed areas. In the Moreton Bay Marine Park there are approximately 140 km^2 of mangroves, with the largest communities in Pumicestone Passage and the southern bay islands, south of Jacobs Well. There are scattered corals to the north and east of Cassim Island and there may also be some coral within and to the south of Fison Channel (the existing highly trafficked public navigation channel). There are areas of soft coral and hard coral reef to the east of Cassim Island, outside the PDA. While mangrove, seagrass and mud flat habitat is present within the PDA the amount present on site is minor in comparison to the broader Moreton Bay area (mangroves ~0.0002% and seagrass ~0.001%). These would all be considered to provide a minor contribution to the overall ecological character of the Moreton Bay Wetland.	Open beaches	Not present	Not Applicable
		Seagrass	Moderate Presence	Minor Contribution
		Salt and mud flats, salt marshes	Moderate Presence	Minor Contribution
		Mangroves and related tree communities	Minor Presence	Minor Contribution
		Rocky reefs	Not Present	Not Applicable
		Sand shoals	Not Present	Not Applicable
Coastal and sub-coastal vegetation	No Tree, wet heat swamps or Grass, sedge and herb swamps were identified by the terrestrial or aquatic ecological surveys as being present within or adjacent to the PDA.	Tree swamp—Melaleuca spp. and Eucalyptus spp.	Not Present	Not Applicable

Environmental Feature	Site Description	Attribute	Presence of Attribute	Contribution to Ecological Character
		Wet heath swamp	Not Present	Not Applicable
		Grass, sedge and herb swamp	Not Present	Not Applicable
Migratory shorebirds	Mudflats within the PDA were identified as providing feeding habitat for migratory shorebirds at low tide including known feeding habitat for the critically endangered Eastern Curlew (maximum of 7 birds observed), the critically endangered Great Knot (a single bird on a single survey) and the vulnerable Bar-tailed Godwit (Western Alaskan) (average of 25 and maximum of 36 birds). Two shorebird roost sites (Nandeebie Claypan and Cassim Island) recognised as important roosting habitat for migratory shorebirds are located immediately adjacent to the PDA boundary, and a third important roost site, Oyster Point, is located 600 m south of the PDA. The Nandeebie Claypan roost is used regularly by migratory shorebirds, particularly on spring high tides. During the summer months late September to March over the period 1995 to 2015, an average of 474 migratory shorebirds were recorded on the surveys when migratory shorebirds were present. Migratory shorebirds recorded using Nandeebie Claypan include the critically endangered Eastern Curlew (an average of 25 and maximum of 180 birds recorded on the 67% of summer surveys when the species was present), the critically endangered Great Knot (an average of 27 and maximum of 90 birds recorded on the 15% of summer surveys when the species was present), the critically endangered Curlew Sandpiper *Calidris ferruginea* very rarely present; only 1-2 birds recorded in 2 of 114 summer surveys) and the vulnerable Bar-tailed Godwit (an average of 609 and maximum of 2,300 birds recorded on the 56% of summer surveys when the species was present). Birds using the Nandeebie Claypan also use the nearby Oyster Point shoreline roost, moving between the two roost sites depending on the height of the tide and extent of disturbance at Oyster Point. The Cassim Island mangroves, located 30m from the PDA boundary, are used daily as a high-tide roost during the summer months by four migratory shorebird species; an average of 699 and maximum of 920 migratory shorebirds were recorded roosting during four summer high-tide surveys. Any works within the PDA (reclamation or dredging) will result in impacts on intertidal mudflats which are currently utilised by wader birds as feeding habitat. There are more than 75 km^2 of intertidal mudflat throughout Moreton Bay. Approximately 40 ha of mudflats including seagrass areas are located within the PDA boundary and therefore is the maximum direct impact that could occur. Even if all of these areas were impacted it would still only result in approximately 0.007% of intertidal mudflats within Moreton Bay being affected. It is noted that a small number of the critically endangered Eastern Curlew were observed feeding in these areas therefore there will be some potential for impact on this species.	Eastern curlew habitat (known)	Moderate Presence	Moderate Contribution
		Grey tailed tattler habitat (known)	Not Present	Not Applicable
		Shorebird feeding areas (intertidal areas, beaches etc.)	Moderate Presence	Minor Contribution
		Shorebird roosting sites (above high water mark)	Not Present in PDA Significant Presence adjacent to PDA	Significant Contribution

Environmental Feature	Site Description	Attribute	Presence of Attribute	Contribution to Ecological Character
	The Nandeebie Claypan and Cassim Island high tide roost site are located adjacent to the PDA and it is acknowledged that both of these areas provide high value habitat for migratory shorebirds. Site design and management measures will be targeted at avoiding any permanent or long term impacts to these areas and their ongoing use as roost sites.			
Threatened plant species	The EBPC Act Protected Matters Search Tool database search identified a number of threatened flora species that may or are likely to occur within the study area. No threatened flora species have been recorded within a 1 km radius of the study area on the databases that were searched, none were detected during the field survey of the study area, and the study area does not contain habitat suitable for any of the threatened flora species identified as having the potential to occur.	*Olearia hygrophila* habitat	Not Present	Not Applicable
		Phaius australis habitat	Not Present	Not Applicable
		Phaius bernaysii habitat	Not Present	Not Applicable
		Thesium austral habitat	Not Present	Not Applicable
		Cryptocarya foetida habitat	Not Present	Not Applicable
		Other (specify)	Not Present	Not Applicable
Marine fauna habitat	Twenty-one migratory marine species were listed as potentially occurring within 5 km of the proposed project using the protected matters search tool. Of these listed migratory species, 12 species are also listed as threatened species. The 'potential area of impact' for the purposes of this assessment comprised shallow inshore waters of Moreton Bay within and adjacent to Toondah Harbour, including Fison Channel. Of the listed migratory species, loggerhead turtles, green turtles, Indo-Pacific humpback dolphins and dugong are highly likely and hawksbill turtles are moderately likely to occur in the potential area of impact. The loggerhead turtle forages in a wide range of intertidal and subtidal habitats, including coral and rocky reefs, seagrass meadows, and non-vegetated sand or mud areas. They tend to maintain small home ranges within their foraging grounds (within approximately 10 to 15 km of coastline). Moreton Bay is an important foraging ground for the loggerhead turtle. Loggerhead turtles are moderately likely to occur in marine habitats within and adjacent to the Toondah Harbour project, particularly in the seagrass beds. Immature green turtles are carnivorous, while adults are generally herbivorous, feeding mostly on algae and seagrass. Adults will occasionally eat other items such as mangrove fruit, sponges and jellyfish. Adult green turtles typically forage in shallow benthic habitats, such as tidal and subtidal	Humpback whales	Not Present	Not Applicable
		Dolphins	Minor Presence	Minor Contribution
		Marine turtles	Minor Presence	Minor Contribution
		Dugong	Minor Presence	Minor Contribution
		Grey nurse shark	Not Present	Not Applicable
		Wallum sedge frog	Not Present	Not Applicable
		Water mouse	Not Present	Not Applicable

Environmental Feature	Site Description	Attribute	Presence of Attribute	Contribution to Ecological Character
	coral and rocky reefs and inshore seagrass beds and algae mats. Green turtles are likely to occur in marine habitats within and adjacent to the Toondah Harbour, particularly in the seagrass beds. Indo-Pacific humpback dolphins have only been recorded feeding in shallow waters. They feed in a variety of habitats, from mangroves to sandy bottom estuaries and embankments to rock and / or coral reefs. They are opportunist-generalist feeders, consuming a wide variety of coastal and estuarine fishes, but also reef, littoral and demersal fishes, and some cephalopods and crustaceans. Given their known population in Moreton Bay and preference for shallow coastal and estuarine areas, the Indo-Pacific humpback dolphin are likely to feed in or traverse within marine habitats of the Toondah Harbour project area. The population of dugongs in Moreton Bay has been estimated to range between approximately 503 to 1019 individuals. The eastern banks of Moreton Bay supported 80–98% of the dugong population at any one time. In this area, there are several dugong 'hot spots' generally associated with seagrass communities. Dugongs feed almost exclusively on seagrass, particularly H. uninervis, H. ovalis and H. spinulosa, and principally inhabit seagrass meadows of shallow, protected bays and mangrove channels. Dugong have been observed near Toondah Harbour and are likely to occur within the marine habitats of the Toondah Harbour project area, particularly in the seagrass beds.			
Fish	No protected fish habitat is located within or adjacent to the PDA and no threatened fish species are expected to utilise the areas including Oxleyan pygmy perch which are generally regarded as restricted to streams, swampy areas and lakes in coastal wallum.	Protected Fish Habitat Areas	Not Present	Not Applicable
		Oxleyan pygmy perch habitat	Not Present	Not Applicable
Lakes and enclosed water bodies	No lakes or enclosed water bodies are present within or adjacent to the PDA.	Window sand lakes	Not Present	Not Applicable
		Perched sand lakes	Not Present	Not Applicable
		Artificial water body habitats (dams, ring tanks etc.)	Not Present	Not Applicable

The assessment of the site's contribution to the environmental character of Moreton Bay can be summarised as follows:

- Estuarine/Intertidal Areas – The PDA contains moderate to minor presence of estuarine and intertidal habitats including sparse seagrass beds, a small area of mangroves and mud flats providing feeding habitat for migratory shorebirds. The PDA contains less than 0.001% of the total area for these habitat types in Moreton Bay and would be considered to provide a **minor contribution** to the overall ecological character of the wetland.
- Coastal and sub-coastal vegetation - No swamps were identified by the terrestrial or aquatic ecological surveys as being present within or adjacent to the PDA therefore the site **does not provide a contribution** to the ecological character of the wetland for these attributes.
- Migratory shorebirds – The PDA area contains intertidal feeding habitat for a number of migratory shorebirds including the critically endangered Eastern Curlew, the critically endangered Great Knot and the vulnerable Bar-tailed Godwit (Western Alaskan). Similar habitat is found throughout Moreton Bay with the site providing less than 0.001% of this habitat type. Two high tide roost sites are located adjacent to the PDA being the Nandeebie Claypan and Cassim Island. These areas are recognised as having high importance to shorebirds in the region and site design and management will focus on avoiding any permanent or long term impacts to these areas. The site is considered to provide a **moderate to minor contribution to shorebird feeding habitat** and a **significant contribution to shorebird roosting sites**. **Figure 2** shows the location of the shorebird habitat and roost sites in relation to the PDA.
- Threatened Plant Species - No threatened flora species have been recorded within a 1 km radius of the study area on the databases that were searched, none were detected during the field survey of the study area, and the study area does not contain habitat suitable for any of the threatened flora species identified as having the potential to occur. The site **does not provide a contribution** to the ecological character of the wetland for these attributes.
- Marine Fauna Habitat - 21 migratory marine species were listed as potentially occurring within 5 km of the proposed project using the protected matters search tool. Twelve of these species are also listed as threatened under the EPBC Act. Of the listed migratory species, loggerhead turtles, green turtles, Indo-Pacific humpback dolphins and dugong are highly likely and hawksbill turtles are moderately likely to occur in or near the PDA. While potential habitat for these species is located at Toondah Harbour similar or better habitat is present throughout Moreton Bay. The site is considered to provide a **minor contribution** to the ecological character of the wetland for its marine fauna habitat attributes.
- Fish - No protected fish habitat is located within or adjacent to the PDA and no threatened fish species are expected to utilise the areas including Oxleyan pygmy perch which are generally regarded as restricted to streams, swampy areas and lakes in coastal wallum. The site **does not provide a contribution** to the ecological character of the wetland for these attributes.
- Lakes and Enclosed Water Bodies - No lakes or enclosed water bodies are present within or adjacent to the PDA. The site **does not provide a contribution** to the ecological character of the wetland for these attributes.

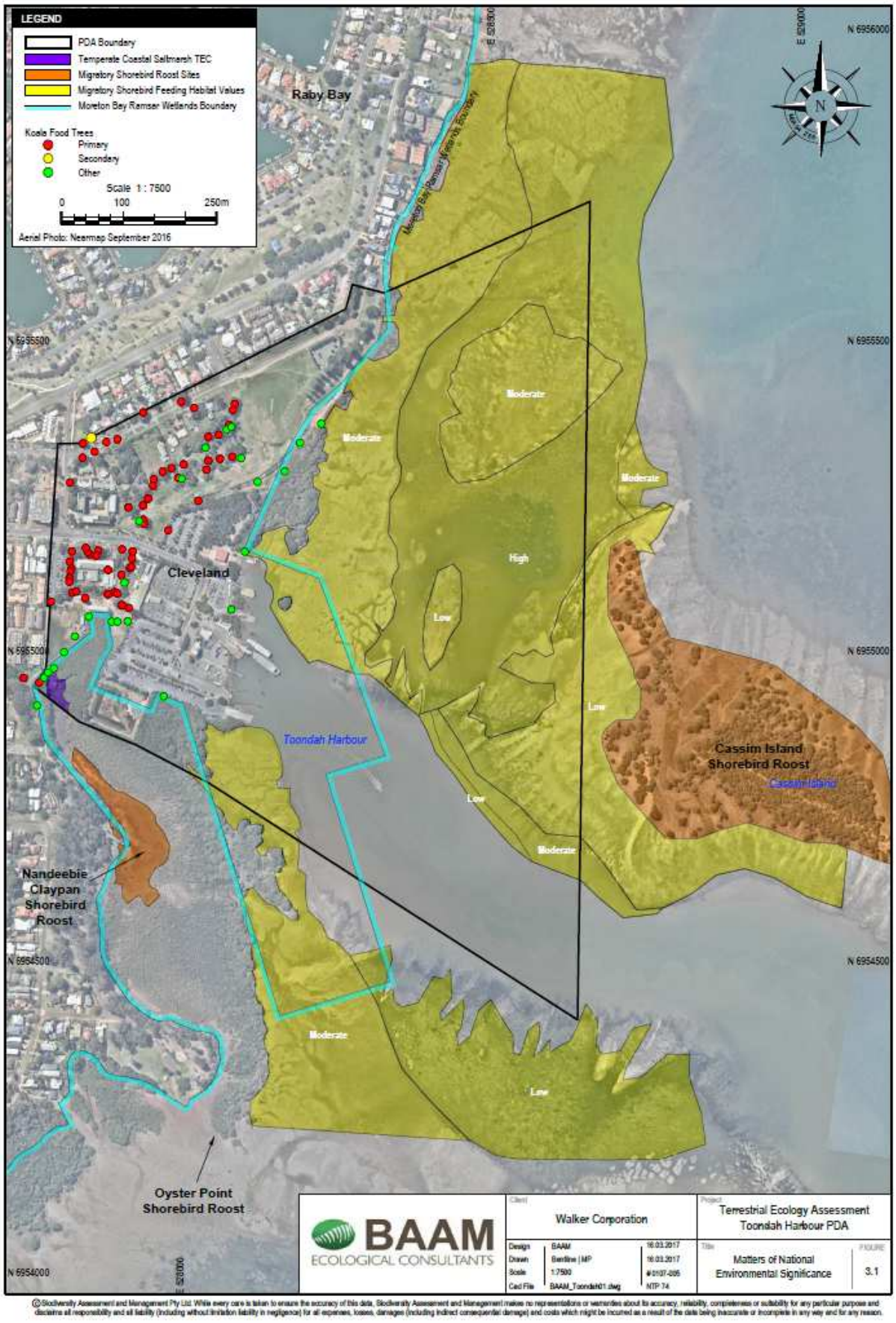


Figure 2: Shorebird Habitat and Roosting Sites

Determination of Significant Impacts

EPBC Act Policy Statement 1.1 – Significant impact guidelines sets out the criteria for determining the likelihood of an action having a significant impact on the ecological character of a declared Ramsar wetland (refer to the introduction for specific criteria). Using the criteria along with the results of the local presence and contribution to the ecological character of the wetland assessment an approach to determining significant impacts at the site level is possible. As identified above the site contributes to the following wetland characteristics:

- Minor contribution to estuarine and intertidal habitat;
- Moderate to minor contribution to shorebird feeding habitat and a significant contribution to shorebird roosting sites; and
- Minor contribution to marine fauna habitat.

Using this information the significant impact criteria can be targeted at those areas of the site contributing to the ecological characteristics. **Table 4** provides a matrix of how the significant impact criteria should be applied based on the contribution to ecological character.

Table 4: Likelihood of Significant Impacts

Criteria	Contribution to Ecological Character			
	Not Present	Minor	Moderate	Significant
Areas of wetland being destroyed or substantially modified	N/A	Unlikely	Likely if changes are permanent	Almost certain unless change is temporary (less than 1-2 year)
A substantial and measurable change in the hydrological regime of the wetland	N/A	Unlikely if not measurable or is within natural variability	Likely if change is measurable, permanent and beyond natural variability	Almost certain resulting in a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland
Habitat or lifecycle of native species being seriously affected	N/A	Unlikely	Likely if permanent Unlikely if temporary or in low season (e.g. outside migratory visitation)	Almost certain if permanent Unlikely if in low season or non breeding (e.g. outside migratory visitation)
Permanent or long term substantial and measurable change in the water quality of the wetland	N/A	Unlikely	Likely	Almost Certain
Establishment of invasive species	N/A	Likely*	Almost certain	Almost certain

Areas of the wetland being destroyed or substantially modified

Areas of the site contributing to the wetland include the estuarine and intertidal habitat. These areas provide a minor contribution to the ecological character of the Moreton Bay wetland therefore potential for significant impacts are considered unlikely.

A substantial and measurable change in the hydrological regime of the wetland
While hydrological changes have not been assessed as part of these investigations any changes have the potential to result in impacts to parts of the wetland up and downstream of the project area. This includes areas adjacent to the PDA that contribute to the ecological character of the wetland such as a 1.2 ha of saltmarsh to the south of the PDA and additional intertidal habitat including seagrass and mudflats (refer to **Figure 2**). The reclamation may also result in changes to the tidal processes within Moreton Bay which may impact on ecologically sensitive areas within Moreton Bay

Detailed hydrodynamic modelling will be carried out as part of the controlled action assessment and will contribute to final design of the site footprint. The design will seek to minimise changes to hydrology and erosion and accretion outside the immediate impact area. The scope of the detailed modelling will be discussed and confirmed with DoEE through the ongoing assessment process.

As detailed modelling is yet to be carried out the precautionary principle has been applied and therefore it is considered likely the project will result in a measurable and permanent change to hydrodynamics in a zone of influence around the reclamation however is unlikely to result in a change that would affect the wetland as a whole.

The habitat or lifecycle of native species being seriously affected
The Toondah Harbour PDA and adjacent areas are considered to provide a minor contribution to the ecological character of the wetland for its marine fauna habitat attributes, a moderate to minor contribution to shorebird feeding habitat and, a significant contribution to shorebird roosting sites.

The project is likely to result in permanent impacts to a small area of shorebird feeding habitat as a result of dredging and reclamation works. While the impact will be small in comparison to habitat for native species present throughout the Moreton Bay Ramsar wetland, as they are permanent impacts and will affect an area of minor to moderate ecological character, there is the potential for significant impacts to occur. If detailed studies identify that significant impacts will occur an offsets package would be developed in consultation with the DoEE and in accordance with the EPBC Act Environmental Offsets Policy. Offsets would be designed at ensure the project results in an overall benefit on shorebirds. Specific activities may include rehabilitation of areas in the Ramsar Wetland to increase the quality and availability of shorebird habitat or implementation of management measures such as fences and noise barriers to improve existing areas of habitat.

It is noted that the assessment of impacts to migratory species found that the carrying capacity of the Moreton Bay wetlands for supporting migratory shorebirds is likely to be underutilised therefore migratory shorebirds may not currently be subject to density-dependent population regulation. This underutilisation is likely a result of factors outside Moreton Bay, in particular impacts to coastal mudflats in the Yellow Sea. A recent study carried out by Studds et al (2017) found "*Yellow Sea reliance was the single most important predictor of variation in population trends*" and that "*Population trends were strongly negatively related with Yellow Sea reliance*".

It is therefore likely any birds displaced as a result of the project would continue to feed in other areas of Moreton Bay.

The project will be designed and managed to avoid any permanent impact on the roosting sites through the use of buffer areas and a number of other measures including:

- A buffer from urban, tourism and retail uses of at least 250m to the Cassim Island roost area. The buffer distances exceed those identified through review of several studies on flight initiation distances for a range of migratory shorebird species (refer to Table 5.1 of **Attachment 6** –Terrestrial Impact Assessment - to this EPBC referral);

- construction of appropriate barriers, such as fences to restrict access; ideally, there should be no public access (by humans and/or domestic animals) to areas identified as important to migratory shorebirds;
- landscape, architecture and urban design to include sympathetic lighting strategies, vegetation screening and sound attenuation; and
- increased community education through mechanisms such as educational program through a proposed wetland education and cultural centre and interpretive signs at access points to shorebird habitats.

While impacts to the high tide roost sites that adjoin the PDA will be mitigated, given these areas provide a significant contribution to the ecological character of the Moreton Bay Ramsar Wetland the precautionary principle has been applied and therefore it is considered likely the project will result in temporary impacts to the roost sites which may have a significant impact on migratory shorebirds. Further detailed studies will be carried out as part of future assessment processes including development of a shorebird management plan to ensure protection of the high tide roost sites is considered during the planning, construction and ongoing use phases of the development.

A substantial and measurable change in the water quality of the wetland

Three turbidity loggers have been installed at and around Toondah Harbour since September 2015 to provide an indication of baseline water quality. Data collected between 9 September 2015 and 22 September 2017 was summarised and provided as **Attachment 7** to the EPBC Act referral.

The mean turbidity over the 24 months of sampling was 20.6 NTU, 30.5 NTU and 12.6 NTU at sites 1, 2 and 3 respectively with 95th percentiles of 74.9, 100 and 40.4. Overall, turbidity was generally highest during the wetter seasons of late spring and summer at all sites.

Water quality in Queensland is protected under the *Environmental Protection (Water) Policy 2009* (EPP (Water)) using Water Quality Objectives (WQOs). The Moreton Bay Environmental Values and Water Quality Objectives (June 2010) specifies a WQO for the project area for turbidity of 5 NTU. The median turbidity at all three sites over the 24 months (7.8 NTU to 11.1 NTU) exceeded the WQO.

While there may be some short term impacts to water quality, in particular turbidity, as a result of dredging and reclamation works the harbour is already subject to high levels of turbidity. The project is expected to provide a long term benefit as dredging will fix existing issues with Fison Channel which frequently re-suspends sediments when used by boats and ferries.

Management measures will be put in place during construction activities to minimise the temporary impacts to water quality outside of the project footprint. Specific measures may include:

- designing the project to minimise the area of sediment and / or soils being disturbed;
- using temporary enclosures (complete enclosures such as sheet piles or alternate enclosures such as silt curtains) to reduce the intensity and spatial distribution of potential impacts;
- isolate the disturbance areas, for example by using sheet piles, silt curtains, oil spill booms, bunding, trenching and / or similar technologies;
- identification and management of acid sulfate soils and other contaminants, through a sediment sampling and analyses plan (SAP) developed in accordance with the National Assessment Guidelines for Dredging 2009;
- developing thresholds for turbidity and suspended solids, and appropriate management (e.g. triggers for ceasing works) for seagrass and corals and monitoring water quality during construction; and
- monitoring changes in seagrass and coral communities post-construction to determine any potential impacts.

Establishment of an invasive species

Management measures will be put in place to avoid establishment of invasive species therefore no significant impacts will result from this criteria.

Conclusion and Potential Benefits

While appropriate management measures will minimise the potential to impact on the Moreton Bay Ramsar wetland it is acknowledged that, if a precautionary approach is applied, the potential for significant impacts exist therefore the project will be referred as a controlled action to allow more detailed assessment under the EPBC Act to be carried out. It is noted that once projects are within a controlled action process offsets and benefits associated the project can be considered.

An ecological character description (ECD) is still in preparation by the State Government for the Moreton Bay Ramsar Wetland. In the absence of a formal ECD for the site, this referral has defined the ecological character of the Moreton Bay Ramsar Wetland to be those key environmental values that contribute to the listing criteria of the site. Further studies will be carried out early in the assessment process to develop an understanding of the critical elements of ecological character for the area around Toondah Harbour at a site level, and place these within the context of the wider Moreton Bay Ramsar Site.

This will include a multi-disciplinary approach to conduct an initial evaluation of the ecological components, ecosystem processes and ecosystem services/benefits. The approach will follow the National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Wetlands (DEWHA, 2008) and information will be drawn from the unpublished Moreton Bay ECD produced in 2008 as well as empirical data and other sources.

Specific activities will include:

- Identification of critical ecological components including physical form, soils and substrates, biota and physico-chemical components;
- Identification of critical ecosystem processes including climate, geomorphology, hydrology, energy dynamics, physical processes, species interactions, and nutrient/biogeochemical cycling;
- Identification of critical ecosystem services/ benefits including provisioning, regulating, cultural and supporting services and linkages with specific beneficiaries; and
- Brief rationale for defining each of the elements as 'critical'.

It is envisaged this will be further refined and detailed in consultation with DoEE and environment and wetland experts. The site level assessment will then form an integral component of the EIS process.

Walker Group have held discussions with a number of State and Local Government departments as well as community groups to identify a range of measures that would provide a benefit to the Moreton Bay Ramsar Wetland. These measures include:

- Identifying new conservation areas using the following criteria:
    - Be located within or adjacent to the Moreton Bay Ramsar Wetland;
    - New areas should contain similar characteristics to those impacted;
    - Conservation outcomes associated with the new areas must be achievable and have an acceptable level of risk of success.
- Investigating the possibility of modifying the Ramsar wetland boundary to designate new areas of waterfowl habitat to the Ramsar site. This may include approximately seven hectares of Moreton Bay south of the PDA into the Ramsar area which contains features of high ecological value such as mangroves and

tidal flats. Tidal areas of Moreton Bay are predominantly owned and managed by the State Government, therefore; negotiations will be held with the relevant agencies to identify how this could be accomplished.

- Community ranger education and sponsorship programs to ensure active land and sea country management in Moreton Bay;
- A feral pest management program;
- Programs for improving water quality from the adjacent catchment;
- Various remediation and rehabilitation projects within and adjacent to the Moreton Bay Ramsar Wetland. These could include management of mangrove incursion in Nandeebie Claypan and rehabilitation of salt marsh south of the PDA. Further opportunities will be discussed with the community and relevant government agencies;
- Koala habitat tree planting in the PDA and surrounding koala movement corridors, and a collaring and monitoring program;
- Use of sea life friendly propellers for vessels using marina (potential Australia first);
- Development of a wetland centre within the development area;
- Creation of new conservation park on eastern boundary with restricted access;
- Implementation of bird hide/s in various areas;
- Community awareness programs (koalas, birds, marine life, Aboriginal cultural heritage);
- Exploration of Moreton Bay fishing net buy back partnership; and
- A pilot migratory shorebird offset in the Yellow Sea, which would address one of the key reasons for a general decline in migratory birds in Moreton Bay.