Each species displays its own pattern of seasonal abundance at the site because of differences in migration behaviour and distribution within Australia (refer Appendix V).

Species of significance

The mouth of the Ross River was recognised in Watkins (1983) as being internationally significant for the number of Lesser Sandplover and Eastern Curlew that have been recorded there and nationally significant on the basis of the number of Whimbrel. Also, the site arguably has international significance on the basis of numbers of Great Knot and Red-necked Stint. Furthermore, migratory shorebirds generally are subject to international conservation agreements between Australia and three other countries. Species of particular interest on the basis of State Legislation are the Beach Stone Curlew, Eastern Curlew and Little Tern.

Other recent appraisals of shorebirds using the Ross River mouth sand bank and associated feeding flats (NRA 2008, Maunsell 2008) have also highlighted the significance of the area for shorebirds and in particularly the occasional very high counts of Great Knot and Red-necked Stint, which on at least three occasions for Great Knot and one occasion for Red-necked Stint, have been above 1% of the East Asian-Australasian Flyway pollution estimates for these species.

3.10.5.4 Potential Impacts and Mitigation Measures – wading and migratory birds

Loss of feeding habitat Lot 773

The development of Lot 773 as a Marine Precinct would mean the permanent loss of about 20 ha of feeding habitat for shorebirds. There is six times this extent of intertidal feeding habitat within 2 km of the Precinct. Furthermore, the quality of Lot 773 as feeding habitat is already compromised by the regular use of the area at low tide by people traversing, often with their dogs, disturbing feeding birds. Without the prospect of the Precinct, this disturbance could perhaps be minimised through controls on the activity of people on the flat. Nevertheless, preservation of Lot 773 as feeding habitat is not considered critical for maintaining the large numbers of shorebirds that frequent the area in general. On the south east bank of the river though, opposite the Precinct, there are important natural habitat features that are considered critical to local bird communities.

Offsite impact of the development on feeding habitat

The area of soft mud on the south-east side of the river between the sand bank and the inner mouth of the river (Area B, Figure 3-60) can be used intensively by shorebirds and, for the period of this study, carried far more shorebirds per hectare than the feeding flats farther to the east. Alteration, diminution or disturbance that affected shorebird feeding on this section of intertidal flat would represent a significant loss of amenity for shorebirds that frequent the area.

Physical changes to the substrate in this area through the encroachment of man made structures or through changed sedimentation patterns need to be minimised and carefully managed. Direct disturbance by people of shorebirds feeding here also needs to be managed but there is a natural safeguard that already exists in the form of deep, soft muds that form the local substrate, which practically precludes pedestrian access to anywhere other the edge of the site.

3.10.5.5 Cumulative impacts and mitigation strategies – wading and migratory birds

Even though the extensive feeding flats that extend to the south east of the sand bank (Area C and beyond, Figure 3-60) will not be directly affected by the Precinct development, other infrastructure that is being planned for the area, including the TPAR, will have the potential of giving far more people ready access to intertidal areas and will increase the likely levels of disturbance of feeding shorebirds by people and dogs. That is, all new infrastructure and plans for access to lands and marine areas on the south-east bank of the river have the potential to detract from a very important site for shorebirds. Movements of people need to be carefully managed to avoid these potential impacts.

The roost site is fundamental to the importance of the area for shorebirds. Without it, the nearby feeding flats will cater for far fewer birds. The roost site serves as a focal point of shorebird activity and a secure place for birds to rest twice every day during periods of high tide.

Threats to the site include:

- Loss or diminution of the extent of the high tide bank through changes in sedimentation patterns brought about by the breakwater(s) that may be built to protect the Precinct;
- Increased human access to the bank that may result from such a breakwater(s) of increased boating activity around the bank; and
- Short term intense disruption of birds using the bank during periods of construction of the breakwater(s).

These potential impacts were considered when assessing the appropriate breakwater footprint for the Precinct and area discussed under Section 1.4.2. A disconnected breakwater configuration was selected that provides protection to the sand bank roost site from direct access and from changes to sedimentation patterns and hydrodynamic flow influences resulting from the Precinct and breakwater construction.

3.10.5.6 Conclusion – wading and migratory birds

Given the significance of the environs of the Ross River mouth for birdlife, particularly the sand bank roost site for shorebirds, the following measures are recommended to ameliorate against adverse impacts from the Precinct and other developments in the area:

- Changes to intertidal bird feeding habitat must be restricted to Lot 773. There should be no direct or indirect consequences of the development on the nature of, or level of interference with other intertidal flats in the area;
- Mangroves on the southeast bank of the Ross River are in good condition with an intact mangrove bird community and should be protected as an important adjunct to neighbouring estuarine habitat;
- Breakwater placement and design should be such that there are no medium or long term threats to the integrity of the offshore sand bank, its extent or its height. It should remain separate from the mainland at high tide as an island refuge for roosting shorebirds and visitation rates by people should not increase;
- If there is to be any interim access to the sand bank during construction of a breakwater then that access needs to be subject to stringent conditions under an Environmental Management Plan to minimise disturbance to birds at the site;

- The roost site should be monitored in future to ensure its integrity does not come under threat from unpredicted changes in sedimentation patterns etc from new marine structures including the Precinct and any breakwater;
- Much is already known about the important features of high tide roost sites for shorebirds and many of these features can be engineered. This knowledge should be put to use if detrimental changes to the roost site do start to occur;
- The cumulative consequences of the TPAR, the Precinct and other developments in the area should be acknowledged through cooperative planning by all parties involved to protect bird habitat at the mouth Ross River. Appropriate management of access by people to this area should be put in place;
- The community should be informed of the significance of the area for shorebirds with appropriate signage and community consultation, including a cooperative approach to continued monitoring of birdlife at the site using organisations such as TRBOC, Queensland Wader Study Group (QWSG) and Australian Wader Study Group (AWSG); and
- Recognition of the area for shorebirds should be made through its listing with the Shorebird Site Network under the Asia Pacific Migratory Waterbird Strategy as noted in the Commonwealth Wildlife Conservation Plan for Migratory Shorebirds.

3.10.6 Aquatic ecology

3.10.6.1 Overview of aquatic studies

The Precinct area includes marine and intertidal habitats in the mouth of the Ross River. No freshwater aquatic habitats are present.

The Study Area surveyed for benthic marine ecology encompasses the TMPP area and reference sites from the immediate surrounds, including within Ross River and seaward of the Project area into Cleveland Bay. The TMPP Area, Lot 773, is located near the mouth of the Ross River and is approximately 32 hectares of shallow tidal sand/mud flats with a rocky foreshore along the northern edge bounding the Eastern Reclaim Area of the port (Figure 3-62). The only natural habitat remnant in this Lot 773 is a small area (approximately 1.5ha) of vegetation that has recruited at the base of the seawall. Impacts to this vegetation are assessed under the Section 3.10.4.

Reference sites in adjacent areas included in the Study Area are (refer Figure 3-62):

- The intertidal area under Lot 773;
- A Swing Basin directly in front of Lot 773;
- The Ross River and its channel;
- East Bank across Ross River from Lot 773 that has sand/mud flats,
- A foreshore area and a sand spit; and
- The areas seaward of Lot 773 in Cleveland Bay that are open water and further offshore some deepwater seagrass meadows.

Marine ecology studies have been collated from information sourced through a focussed desktop assessment of available information (including Government agencies databases) and from the results of a benthic marine ecology survey that enhances the existing knowledge of aquatic systems occurring within and adjacent to the Project Study Area.

The marine benthic survey findings come from a once off sampling event of 5 days in duration in October 2008 and may not reflect potential seasonality of marine fauna across the Study Area. However, the historical data and available information on the Project area and adjacent habitats is thorough and provides a strong seasonal perspective within which the survey data is used in assessing the potential impacts of the TMPP on the benthic marine ecology.

3.10.6.2 Objectives and methodology – aquatic ecology

The objective of the benthic marine ecology survey was to assess the current status of benthic taxa and characterise the benthic habitats in the TMPP area and adjacent habitats, defined as the Study Area. A review of available literature, databases and consultation with other researchers found that the most recent benthic surveys within the Project area were undertaken over seven years ago (Cruz 200, Neil 2001 and Neil *et al.* 2001) and thus previously reported species composition data are no longer current, although data regarding seasonal variability of tropical systems are relevant. The detailed findings from the literature review and consultation processes are provided in Appendix T.

The marine communities of the project area were characterised by surveying the subtidal and intertidal habitats of the Project area and immediate surrounds. Simultaneously the area was assessed for the presence of any marine pests of concern. The methodology utilised in this program is detailed in Appendix T.

Department of Primary Industries and Fisheries (DPI&F) undertook seagrass survey work for POTL in 2007 and 2008 and comprehensively assessed spatial and temporal variability of seagrasses within the Port of Townsville and adjacent marine environments (Rasheed and Taylor 2008). Considering this recent survey work, it was not necessary to undertake further broad scale seagrass meadow assessments. Instead focussed characterisation of seagrasses at sample sites was conducted during other field activities that built upon information collected during the DPI&F surveys. This enables ecosystem assessment of the meadows likely to be influenced by any proposed development works in the context of their use by other species.

The marine community assemblages (including seagrasses and any associated fish taxa) were characterised for diversity, spatial distribution and relative abundances. The surveys enhanced the existing information on these marine benthic communities and provided the ability to assess the potential impacts to benthic communities and any protected species and propose appropriate mitigation measures.

3.10.6.3 Survey design

To assess the current status of benthic taxa (fish and macroinvertebrates) and characterise the benthic habitats in the Study Area, areas to be surveyed were determined from observations made during a megafauna and intertidal seagrass aerial survey. The areas include all habitats potentially affected by the Precinct.

The sites were spatially stratified and not randomly distributed, a sampling approach that is appropriate for characterising soft sediment taxa that are characteristically disparate in their

distribution (e.g. Cruz 2000, Neil *et al*. 2003, Roberts *et al.* 1998, Smith and Rule 2001). The number of sites investigated within each location was determined using methodology defined in Hayes *et al.* (2005a) that allowed representative samples of the benthic taxa within each location to be collected.

A once-off sampling event was undertaken to complete all benthic sampling and provide a baseline of species distributional data. Sampling was conducted both from shore and boat environments. The following locations, and number of sites within each location, were targeted for soft sediment and intertidal community assemblage sampling (refer Figure 3-63):

Subtidal

- The Marine Precinct Project Area and immediate surrounds (Lot 773, 5 sites);
- Seaward of the Marine Precinct Project area, in the proposed breakwater footprint area (2 sites), and in the seagrass area (3 sites); and
- Up Ross River adjacent to the currently in-use pile moorings (10 sites).

Intertidal

- Marine Precinct Project Area (Lot 773, 5 sites);
- Sand Spit (6 sites); and
- East Bank, along the foreshore edge of the sand/mud flats adjacent to the Sand Spit (5 sites).

Subtidal sites were sampled using a benthic sled and camera set up. Benthos captured in the sled net was identified to lowest taxonomic unit. Intertidal soft sediment habitats were sampled using 1m x 100m strip transects. Benthos within the footprint of the transect was identified to lowest taxonomic unit.

In addition, visual non-structured surveys were conducted at the rocky shore habitat in the proposed TMPP area in order to compare the current assemblages within the area to historical data (e.g. Neil *et al.* 2001, Neil 2001). Beach walks were done at the Sand Spit and along the Precinct area looking for recent signs of benthic faunal activity such as crab exuviae and moults. Cast nets and crab pots were deployed in the Ross River and the Precinct area to collect information on the fish and crab species present (Figure 3-63). Additional detail in regards to sampling methodology approaches is provided in Appendix T.

3.10.6.4 Description of environmental values

The TMPP area and adjacent areas include a number of key marine benthic habitats:

- The Marine Precinct Area is a shallow tidal sand/mud flat with small areas of intertidal beach, rocky foreshore and remnant natural vegetation;
- Seaward of the Precinct is an extensive deepwater seagrass meadow;
- Up Ross River the eastern side remains fairly natural with small tributaries while the western side has been greatly modified, with rock walls and industrial development;
- At the mouth of the Ross River, the East Bank is a mud flat area that abuts fringing mangroves; and
- At the edge of this mud flat there is a highly mobile Sand Spit that changes shape according

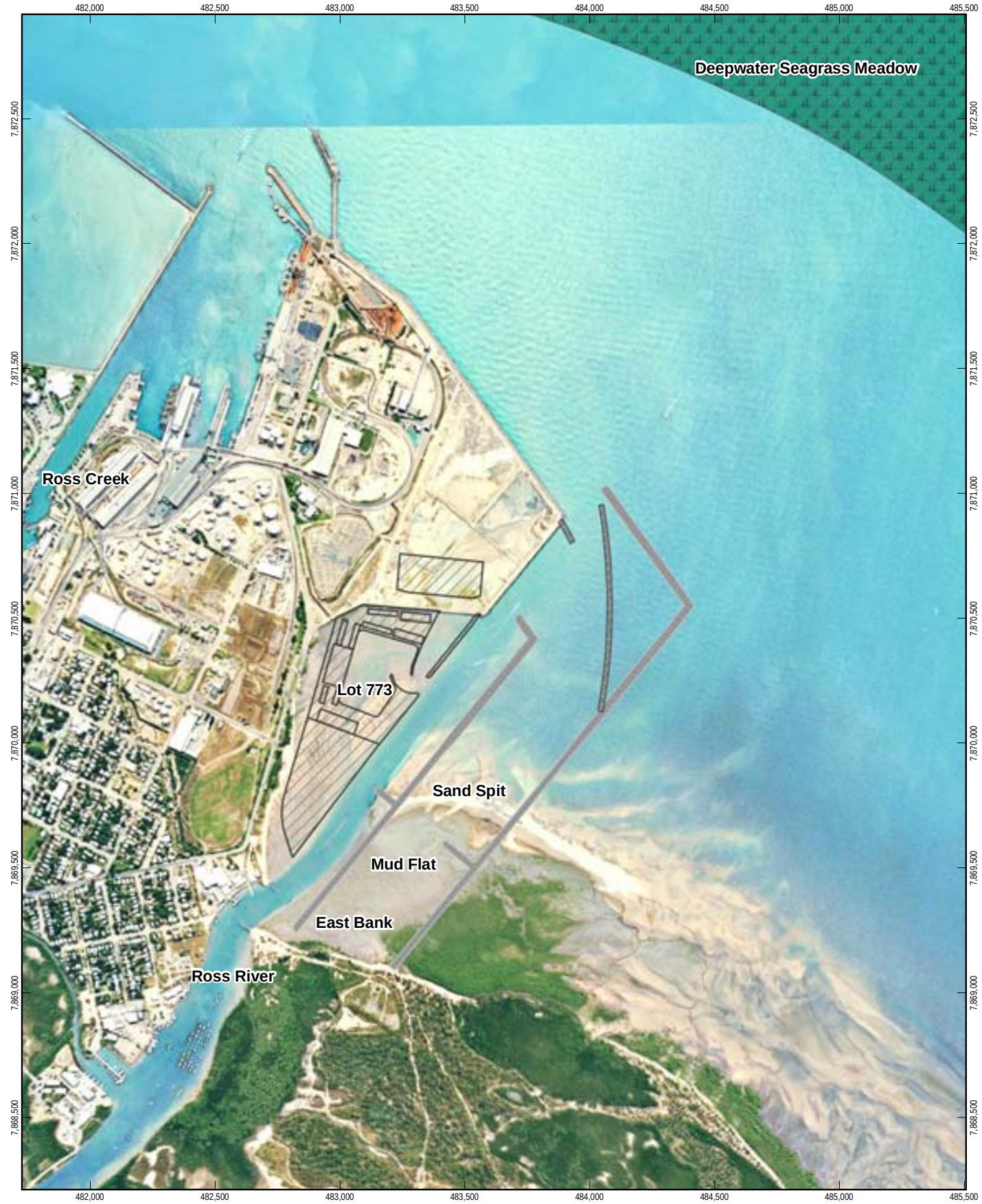
to seasonal and flood influences.

A range of communities was present across each of these habitats. The subtidal benthic communities were dominated by small marine molluscs, and to a lesser extent crustaceans (crabs and prawns), with animals from most other benthic groups present including marine worms, echinoderms (sea stars and sea urchins), fish and seagrass. The intertidal benthic communities were, similar to the subtidal communities, dominated by small molluscs, mostly snails. There were also large numbers of fiddler crabs, soldier crabs and marine worms. Thousands of crab burrows were observed.

No marine pests of concern for the Townsville region were detected in any of the samples collected during this survey. Species of concern were determined based on information provided in Hayes *et al*. (2005b) and through the National System for the Prevention and Management of Introduced Marine Pests.

The seagrass areas offshore from the Precinct and the East Bank habitats supported the greatest diversity subtidally and intertidally respectively. The majority of crabs were observed in this area and the mud flat forms a significant feeding ground for wading and migratory birds for the region, a matter reported under Section 3.10.5. A few seagrass species were also recorded among the fringing mangroves of this site. Fish assemblages, including juveniles of species targeted by commercial and recreational fishers, were more common and more diverse along the East Bank areas, typically associated with fringing mangroves. Rocky shore assemblages occupying the Eastern Reclaim Area breakwaters that form the northern edge of Lot 773 supported taxa that are common to the Townsville region.

The Precinct area had a subtidal benthic community of relatively low diversity, with 25 species present, however the intertidal area was more diverse with 28 species recorded (there are usually many more benthic species present in subtidal soft bottom communities compared with intertidal communities).



LEGEND

Breakwater Option C (Preferred)

Min and Max Breakwater Options

Proposed Marine Precinct

Deepwater Seagrass Meadow (Summer Baseline Survey 2007)

1:20,000 (at A4)

0 100 200 300 400 500

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Marine Ecology
Sample Areas

Job Number	42-15399
Revision	A
Date	01 July 2009

Figure 3-62

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Aerial (flown 2004) - ©The State of Queensland (Department of Environment and Resource Management); Townsville Summer Baseline Deepwater Seagrass Meadows 2007 ©The State of QLD (Department of Primary Industries and Fisheries). Created by: TH

LEGEND

- Cast Net
- Crab Pot
- Benthic Fauna Grab
- Beach Walk
- Intertidal Belt Transect
- Rocky Shore Transect
- Benthic Sled Transect
- Deepwater Seagrass Meadow (Summer Baseline Survey 2007)

1:20,000 (at A4)

0 100 200 300 400 500

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Benthic Sample Locations

Job Number	42-15399
Revision	A
Date	01 July 2009

Figure 3-63

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Aerial (flown 2004) - ©The State of Queensland (Department of Environment and Resource Management); Townsville Summer Baseline Deepwater Seagrass Meadows 2007 ©The State of QLD (Department of Primary Industries and Fisheries). Created by: TH

Across all these habitats, the surveys recorded 105 species from the subtidal waters and 44 taxa from the intertidal areas. This included taxa recognised to be protected and regulated under the Fisheries Act 1994. All marine plants are protected under the Fisheries Act 1994; this survey detected three seagrass species, 10 algal taxa and three mangrove taxa but only algae and mangroves were found within the Lot 773 footprint. All molluscs (bivalves and gastropods) and a large number of fish taxa are regulated under the Fisheries Act 1994. Subtidally 17 and intertidally 19 regulated taxa were detected. Over 80% of these were small molluscs (non-commercially targeted, mainly gastropods) although recreationally targeted mud crabs, were also found within the footprint of Lot 773. These were, however, also found elsewhere in the study area and were not unique to Lot 773.

One species of conservation significance was observed, a green turtle (*Chelonia mydas*) in the Ross River channel in front of the Marine Precinct Project area. One marine migratory listed species was also observed, a dugong (*Dugong dugon*) at the edge of the deepwater seagrass meadows. In addition a sea snake was observed at the mouth of the Ross River; sea snakes are listed as other protected matter species in the EPBCA. Habitat requirements for a number of other species of conservation significance, marine mammals and reptiles, were present in the Study Area, and these species may use the area from time to time, including nine species of NES, 14 migratory and 68 Other Protected Matter species.

Data analyses support the diversity descriptions of the study sites with the seagrass meadow being the most diverse assemblage and supporting taxa different to other areas surveyed. The channel and sand spit environs support the least diversity and the flora and fauna present in the Precinct were also found in other locations surveyed, although in differing relative proportions.

Taxa sampled during the survey were consistent with those detected previously by Neil *et al.* (2001) and Rasheed and Taylor (2008). This suggests that seasonal and long term temporal variability has had little influence on the biodiversity of this area with many of the species persisting over time and under the influence of various impacts, including storm and flooding events and dredging activities. This indicates these communities are either resilient to impacts and recover quickly (as shown by Neil 2001 for a subset of the taxa found here) or are able to recolonise habitats rapidly after disturbance events experience to date.

The TMPP is not expected to significantly impact on any of these NES, migratory or Other Protected Matter species. This conclusion is also discussed further in the marine megafauna Section 3.10.7 following and Wading and Migratory avifauna Section 3.10.5.

The TMPP is expected to impact on benthic invertebrate communities. In order to address what impacts and mitigation measures are appropriate to avoid impacting upon marine ecology values of the areas associated with development and operation of the Precinct facility, an impact risk assessment has been undertaken and is discussed in detail in Appendix T.

3.10.6.5 Potential Impacts and Mitigation Measures – aquatic ecology

The TMPP will have a number of permanent impacts on the marine ecological values of the area in which it is located. The majority of the impacts involve the removal of an area (approximately 32 ha) of intertidal sand/mud flat on the western bank of the Ross River that forms the bulk of Lot 773. Further, the loss of seabed associated with the footprint of the breakwater (approximately 2 ha in total) will also occur. In addition, a range of temporary

impacts are expected as a result of construction activities, including dredge plume impacts and noise impacts.

In developing the Reference Design for the Precinct consideration was given to potential impacts upon marine species and care has been taken to incorporate features that address the 11 principals guiding development for fish-friendly structures, as provided by the Queensland Government Fish Habitat Guideline FHG 006.

No removal of seabed or disturbance of marine habitats is proposed for the eastern bank area of the Ross River, across from the Lot 773 footprint. The area is heavily utilised by marine wading and migratory birds, which is reported under the Marine and Migratory Avifauna assessment for this EIS. It also forms an important habitat for fish and crab species and is fringed by a variety of mangrove and seagrass species. Avoiding impact upon this area aligns with principals of FHG 006 including sustainable development, avoiding sensitive habitats and minimising disturbance and adopting an integrated approach to the development process. The East Bank, Sand Spit and mud flat area may be the subject of further studies in regard to potential siting of boat ramp facilities outside this EIS process. Data collected during this investigation may provide a baseline from which further studies can work. Impacts associated with the loss of any marine environs and taxa associated with potential boat ramp siting investigations, including cumulative impacts following on from development of the Precinct, would need to be considered at that time.

The proposed configuration of the Precinct with an inner harbour increases the opportunity for re-establishment of soft sediment communities affected during the construction process and provides appropriate flushing to not impact upon water quality and ergo marine species, including fishery species. The construction approach of using sloped rock revetment walls provides interstitial habitat both tidally and subtidally that may increase the habitat available in this area for fish and crab species. This integrated approach to design and construction with environmental considerations and avoidance of critical habitats recognises the risks and potential benefits that artificial structures may bring to improve the fish habitat values of the development footprint, adhering to the guiding principals of FHG 006.

Prior to the construction of the Precinct a road and rail link to the proposed port site will be constructed. This road and rail corridor will enter the port site from the east, passing through the land on the eastern side of the Ross River mouth and crossing Ross River to the south of Lot 773. The actual design and construction of this infrastructure is the subject of another approval process by the Department of Main Roads. A range of cumulative impacts may occur in regard to construction effects on marine megafauna species and removal of benthic species.

The impacts on marine ecological values expected to result from the Marine Precinct project, either during construction and/or operation, include:

- Direct impacts (both potential and probable);
  - Removal of individual organisms;
  - Damage to individual organisms from direct contact related to construction activities;
  - Removal of individual organisms as a result of Precinct user activities;
  - Damage to individual organisms as a result of Precinct user activities;
  - Impact to fauna by boat strike;

- Increased rubbish that may smother or damage individual organisms; and
- Decreases in water quality from dredging, construction, spills of fuel or other hydrocarbons, paint, solvents, cleaners or other pollutants.

- Indirect impacts (both potential and probable);
  - Decreased water quality from construction disturbance of sediments around the Precinct site;
  - An increase in sedimentation that may result in the smothering of adjacent benthic communities;
  - Degradation of habitats through continual human usage (including inappropriate waste management, boat fuel spills);
  - Increased disturbance to habitats from increasing visitation/usage;
  - Decreased water quality resulting from inappropriate waste management or an increase in sediments and pollutants as a result of construction waste or land use changes;
  - Noise and vibration impacts to marine reptiles and mammals from in-water construction or ongoing operational activities; and
  - Increased bioturbation from propeller activity reducing water quality and disturbing marine assemblages.

Decline in species diversity, removal of species or reduced use of the area by mobile marine fauna may occur as a consequence of these potential impacts. This may have flow on effects for the value of the marine ecosystems within the Townsville region. To address this potential for impact on marine species an assessment of the risk of each impact and mitigation measures is provided in Table 3-55.

Table 3-55 Risk assessment for marine ecological values (marine megafauna further addressed in following section)

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
Construction Works				
Pile driving, dredging and general construction in water	Increased sedimentation in the Ross River, declines in water quality, increased siltation.	(4, 4) 16 High	Consideration of use of sediment / silt mitigation devices like silt curtains as appropriate for construction/dredge methodology. Consideration of timing of dredging activity to not coincide with rough weather that would exacerbate impacts. Implement construction and dredge management plans including approaches to hopper de-watering, overflow, monitoring of water quality conditions and use of water quality triggers to halt dredging if unacceptable decline in water quality detected.	(2, 4) 8 Medium
	Acoustic impacts on marine fauna leading to avoidance of area.	(2, 4) 8 Medium	Use of warning strikes pre full drive of pile (if found to be effective). Avoid activities that will disturb breeding/migratory wading avifauna. Implement a megafauna management plan. Consider use of a megafauna spotter on vessel to manage conduct of activity when animals within 50m of vessel.	(1, 4) 4 Medium

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
	Vibration impacts on marine fauna leading to avoidance of area.	(2, 4) 8 Medium	Use of warning strikes or similar prior to commencement of pile driving (if found to be effective). Avoid activity if breeding of megafauna noted in project the area. Implement a megafauna management plan to mitigate impacts. Consider use of a megafauna spotter on vessel to manage conduct of activity when animals within 50m of vessel.	(1, 4) 4 Medium
	Direct impacts by dredge plant on marine megafauna leading to capture / reduction in biodiversity.	(3, 3) 9 Medium	Maintain visual check for megafauna activity in path of dredger and consider operational avoidance measures to reduce risk of impact to turtles, particularly when within 50m of operations. Use bucket dredge (backhoe). If possible use of trailer suction dredge should include turtle exclusion devices like tickler chains. Implement a megafauna management plan to mitigate impacts.	(2, 3) 6 Medium
Light spill from construction plant	Disorientation by marine fauna leading to inappropriate clustering of fauna to construction site.	(2, 3) 6 Medium	Install lighting that includes reduced risk of spill into marine environment through use of light screens. Consider lighting options and safety needs and use most appropriate wattage / lighting type for minimising impact on marine taxa. Use limited lighting adjacent to water. Adopt timed lighting to minimise light pollution. As no turtle nesting has been observed within immediate vicinity, monitoring of turtle nesting behaviour is not considered relevant, though consideration is given to hatchling dispersal and Precinct lighting as noted above.	(1, 3) 3 Low

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
Increased occurrence of rubbish from construction activities	Waste materials, domestic rubbish enter marine environment and smother marine systems, ingested by marine fauna leading to death or maiming.	(3, 3) 9 Medium	Implement waste management plans and measures including provision of solid waste containers for recycling or disposal of via a licensed contractor. Educate onsite users of facility in regards to appropriate waste management requirements.	(2, 2) 4 Low
Increased vessel traffic (construction vessels)	Increased boat strike of marine fauna leading to death or maiming.	(3, 2) 6 Medium	Provide education and training to vessel operators in regards to monitoring for and management of interactions with marine fauna. Implement fauna spotting and appropriate avoidance measures whilst dredging to reduce risk of impacting turtles. Consider working with regulatory agencies to implement Go Slow Zones in Port vicinity and over adjacent shallow foraging habitats. Implement a megafauna management plan to mitigate impacts. Consider extension of 6 knot speed restriction of Ross River to outer breakwater.	(2, 2) 4 Low
	Increased potential marine pest introductions.	(3, 4) 12 High	Adhere to national and state biofouling and ballast water management guidelines and requirements for both domestic and international shipping traffic. Precinct facility not established as first port of call for quarantine clearance of incoming vessels. International vessels to be of low risk of carrying marine pests prior to entering Precinct facility. AQIS procedures to be adhered to.	(2, 4) 8 Medium

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
Habitat removal as result of construction and dredging activities for both Precinct and breakwater facility	Benthic marine habitat, inter and subtidal, removed and communities supported by this habitat denuded. Habitat and communities represented elsewhere in region including Rowes Bay and Pallarenda.	(5, 2) 10 Medium	Implement a dredging and spoil disposal management plan considering avoidance of marine habitats used frequently by marine megafuna. Implement a construction environmental management plan. Consider offsetting impacts from benthic habitat removal by remediating or rehabilitating other degraded environs.	(5, 1) 5 Medium
	Reduced water quality from construction and dredging activities providing indirect impact on adjacent communities. Potential for reduced biodiversity.	(3, 3) 9 Medium	Implement construction and dredge management plans including approaches to hopper de-watering, overflow, monitoring of water quality conditions and use of water quality triggers to amend dredging approach (eg consider introducing silt curtains to the extreme of halting dredging) if unacceptable decline in water quality detected.	(2, 3) 6 Medium
Land use change	Removal of existing impacts to intertidal / subtidal habitats of Lot 773, including waste pollution.	Positive benefit	Existing impacts to be removed.	Positive benefit
	Loss of beach environment for recreational opportunities during construction activities.	(5, 2) 10 Medium	Consider opportunities to offset losses by creating alternative recreation in other locations. Maintain presence of sand bank and mud flat across river from Precinct to continue recreational activities in these areas as they currently occur.	(5, 1) 5 Medium

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
	Increased potential for fuel, hydrocarbon, chemical (etc) spill during construction activities.	(4, 3) 12 High	Identify hazardous material handling requirements and implement waste management and emergency response procedures. Suitable and sufficient oil and chemical spill response equipment to be available and easily accessible. Training in spill response and reporting to be undertaken.	(2, 3) 6 Medium
Operational Works				
Operation of breakwater facility	Alteration of local hydrodynamics	(2, 5) 10 High	Adopt design configuration to minimise impacts on hydrodynamics. Maintain smallest practical footprint of breakwater and disconnection from shore to minimise impacts.	(1, 5) 5 High
	Creation of interstitial habitat and provision of additional hard substrate subtidally.	Positive benefit	Provides benthic habitat that can be recolonised by taxa. Counteracts removal of existing rocky shore area that bounds northern edge of Lot 773.	Positive benefit
Operation of Precinct facility	Alteration of local hydrodynamics.	(2, 5) 10 High	Adopt design configuration to minimise impacts on hydrodynamics.	(1, 5) 5 High
	Acoustic impacts, interference with communication of marine fauna leading to temporary avoidance or displacement.	(2, 4) 8 Medium	Facilitate construction to consider design strategies for in-water noise reduction. Like facilities exist in Ross River currently and fauna currently use area.	(1, 4) 4 Medium
	Vibration impacts, interference with communication of marine fauna leading to temporary	(2, 4) 8 Medium	Facility construction to consider design strategies for in-water vibration impact reduction.	(1, 4) 4 Medium

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
	avoidance or displacement.			
	Creation of inner harbour habitat.	Positive benefit	Counteract removal of existing subtidal benthic substrate associated with footprint of Precinct in Lot 773. Provides benthic habitat that can be recolonised by taxa.	Positive benefit
Increased occurrence of rubbish in local area	Waste materials, domestic rubbish enter marine environment and smother marine systems, ingested by marine fauna leading to death.	(3, 4) 12 High	Implement waste management plans and measures including provision of solid waste containers for recycling or disposal of via a licensed contractor. Educate onsite users of facility in regards to appropriate waste management requirements.	(1, 4) 4 Medium
Light spill from Precinct Facilities	Disorientation by marine fauna leading to inappropriate clustering of fauna to Precinct site.	(2, 5) 10 High	Install lighting that includes reduced risk of spill into marine environment through use of light screens. Consider lighting options and safety needs and use most appropriate wattage / lighting type for minimising impact on marine taxa. Use limited lighting adjacent to water. Adopt timed lighting to minimise light pollution. As no turtle nesting observed within vicinity monitoring of turtle nesting behaviour not considered relevant.	(1, 5) 5 High
Land use change	Potential provision of designated public access facilities within Precinct.	Positive benefit	Consider provision of public access facilities within Precinct.	Positive benefit

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
	Increased potential for fuel, hydrocarbon, chemical (etc) spill during operational activities.	(3, 4) 12 High	Facilities to be designed to standards to mitigate pollution potential. Identify hazardous material handling requirements and implement waste management and emergency response procedures. Suitable and sufficient oil and chemical spill response equipment to be available and easily accessible. Training in spill response and reporting to be undertaken.	(2, 4) 8 Medium
Increased vessel traffic	Perceived increased boat strike of marine fauna leading to death, maiming. Vessel traffic is likely to remain at levels similar to present as no additional vessel accommodation is provided. Vessel traffic may at present temporarily displace fauna or disturb foraging behaviour in areas adjacent to the TMPP.	(3, 4) 12 High	Provide education and training to Precinct operators in regard to monitoring for and management of interactions with marine fauna. May include public education information provisions waterside. Provide designated shipping channels and go slow (6 knots) areas to decrease probability of collision.	(2, 3) 6 Medium
	Increased benthic disturbance due to prop wash.	(2, 4) 8 Medium	Provide designated shipping channels and go slow (6 knots) areas to decrease probability of benthic habitat disturbance. Channel depths to be maintained. Consider extension of 6 knot speed restriction of Ross River to outer breakwater.	(1, 4) 4 Medium
	Increased potential marine pest	(3, 4) 12	Adhere to national and state biofouling and ballast water management guidelines and requirements.	(2, 4) 8

Activity	Expected impact	Preliminary risk assessment (C,L) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (C,L) Score
	introductions.	High	Precinct facility not established as first port of call for quarantine clearance of incoming vessels. AQIS procedures to be adhered to.	Medium

3.10.6.6 Cumulative impacts and mitigation strategies – aquatic ecology

The TMPP involves the construction of an industrial marine precinct about the mouth of the Ross River. Consequently the marine benthic habitats in this area will be markedly disturbed. The main potential construction impacts include removal of benthic habitat, declines in water quality associated with construction events and potential impacts to marine megafauna from vessel operations. The main potential operational impacts include continuous disturbance of benthic marine systems, impacts to water quality, impacts to marine megafauna from vessel operations and increased potential of pollution to the marine environment from changed use. Mitigation strategies against each impact were identified in the preceding section under Table 3-55.

Within the Townsville region a number of other construction projects are occurring that have the potential to result in confounding or cumulative impacts. These other projects include the development of:

- The Townsville Port Access Corridor road and rail link, including a bridge across Ross River adjacent to the Precinct site;
- Development of Berth 12 to the north of the Precinct site in the outer harbour area of the port;
- Berth 8 and 10 expansion within the inner harbour of the port; and
- The Townsville Ocean Terminal (TOT) to the west of the port.

Each of these adjacent projects is likely to involve adverse effects on the marine environment including removal of benthic seabed habitat, dredging operations and construction operations that may impact upon water quality and vessel movements that may effect marine fauna utilisation of the area.

The benthos that will be directly affected by construction of the Precinct is known to occur in other locations within Townsville region including in other locations within the Port, Rowes Bay, Pallarenda and Magnetic Island. It is not considered to be a community or ecosystem of high value either in its own right or as a critical feeding ground for other, higher order, species. Cumulative removal of this type of seabed community is not expected to have a negative effect on the importance of the benthic marine habitats of the Townsville region. Nor it is anticipated to reduce biodiversity of the region significantly.

The mud flat across Ross River from the Project Area hosts a similar diversity to the benthos of the area that will be removed as a direct result of construction. Strategies to avoid impacting the mud flat site, and maintenance of the mud flat in perpetuity should be considered to provide opportunities within the immediate area of the Precinct for continued presence of taxa that will be removed as a result of construction of the Precinct. Development of the inner harbour of the Marine Precinct will provide future opportunity for some of the Lot 773 area to be recolonised with benthic taxa from adjacent environs like the mud flat. This may partially offset some of the habitat losses associated with direct removal. Creation of interstitial rocky shore habitat both intertidally and subtidally through provision of rock revetment walls of the Precinct and development of the breakwater may also partially offset some of the habitat losses associated with direct removal.

Megafauna species were noted within the Ross River area with only stingrays noted to be using Lot 773 as a potential feeding site. Stingrays could be targeting the benthic infauna and epifauna occurring within the sediments of Lot 773 and surrounding areas, including the small crustaceans and bivalve molluscs reported in this study. Similarly, crab and fish fauna were also noted within this area and are likely to also be targeting benthic fauna as a food source. As noted above, these benthic communities are not unique to the Townsville region and are well represented to the north and south of the Port environ. Removal of the benthic habitat associated with Lot 773 is, therefore, not likely to negatively affect the stingray, crab or fish populations of the Townsville region. This conclusion is also supported by sightings of similar taxa using the mud flat across Ross River from the Marine Precinct area. As noted above, maintenance of the mud flat environ would provide a continued opportunity for these fauna to use the mouth of the Ross River for feeding.

Construction activities associated with the TPAR, Berths within the PoT and the TOT will also all likely impact negatively upon the benthos occupying areas of the seabed in the direct vicinity of each development. The cumulative impact of this habitat removal in conjunction with the development of the Precinct is not expected to negatively effect prevalence of the benthic flora and fauna detected during this survey in the Townsville region given they are well represented. Including in areas that will not be affected by construction activities to the north and south of the Port environment such as Cape Pallarenda and around Magnetic Island.

Megafauna other than stingrays, including turtles, dugong or dolphins, were not noted using Lot 773. This is supported by a lack of key food groups for these megafauna within the area, including, but not limited to, seagrasses. Seagrasses were found offshore of the mouth of Ross River, a finding consistent with that reported by Rasheed and Taylor (2008). There is potential for degraded water quality to impact these offshore meadows particularly if dredging activities for the TPAR, Berth 12 and Precinct coincide and produce a larger or more persistent plume than anticipated by any single activity. Potential water quality impacts quality impacts are examined under a detailed study provided as Appendix J of this EIS and summarised in Section 3.9, which includes information on construction dredging assessments and dredge plume potential.

Seagrass communities are recognised as important ecosystems for maintenance of seabed stability, water quality and biodiversity (Collier and Waycott, 2009). In addition to their intrinsic value, seagrasses are known to act as nursery grounds for juvenile fish, which may be targeted by commercial and recreational fishers, or be an important food source for other fish and megafauna species. Seagrasses are also an integral food for marine megafauna including turtles and dugongs. Collier and Waycott (2009) identify a number of natural and anthropogenic activities that may impact the persistence of seagrass meadows and cite high sediment loads as a particular feature of the Townsville region. Rasheed and Taylor (2008) note that seagrasses in the vicinity of the Townsville port are likely adapted to high levels of turbidity both as a result of naturally occurring high turbidity for the area and also in response to existing levels of maintenance dredging and shipping activities. These compounding influences on turbidity are, however, recognised to be short-lived and events to which the meadows have some resilience. Significant impacts may occur to the presence, taxonomic composition or biomass of meadows when the severity or duration of any particular impact exceeds levels of natural variation (Carruthers *et al.,* 2002, Erftemeijer and Lewis, 2006 and Orpin *et al*. 2004). Rasheed and Taylor (2008) and Collier and Waycott (2009) both note considerable risk of

impact to seagrass meadow prevalence in the Townsville region from prolonged periods of reduced water quality resulting from compounding influences.

Given the ecological importance of seagrasses within this region, and the considerable risk of cumulative impacts to seagrass meadows from concurrent project development, consideration should be given to monitoring the presence and prevalence of seagrass meadows and the quality of associated water bodies adjacent to the port to determine if any negative influences from construction and operational activities affect these sensitive ecosystem receptors. Management response plans to declines in water quality and / or prevalence of seagrass meadows linked to development of the Marine Precinct should be developed. These may include, for instance, cessation of dredging activities to enable water quality levels to return to background conditions if unacceptable declines in water quality during dredging from dredging activities were detected.

Additional cumulative impacts that may result from increased traffic activity associated with construction activities in the mouth of Ross River (TPAR and Precinct) include increasing potential for boat strike of megafauna or increased avoidance of the area by fauna. Development of a construction vessel management plan taking into consideration cumulative impact potentials and addressing management strategies including speed limitation, extension of 6 knot speed restricted area to the offshore breakwater, need for observation for marine megafauna, appropriate strategies to avoid interaction with megafauna and reporting of any interactions should be considered.

Direct impacts as a result of increased or changed utilisation of Lot 773 area will not likely be compounded by cumulative impacts from other projects once the reclamation activities for construction have occurred. This area is already heavily utilised by public groups undertaking activities including, but not limited to, dog walking, fishing, beach collection and picnicking. Beach collection activities range from shell collection through to sourcing of bait species for estuarine fishing. It is estimated that at least 30,000 people visit the beach on an annual basis for various recreational activities. Reclamation and construction of the industrial precinct will remove the capacity for this activity to continue. As adjacent areas subject to development do not offer the same/similar recreational opportunities there is little potential for any cumulative impacts from adjacent developments. Boating (tinny) activities and jet-ski activities that currently use the beach area for recreational purposes will still be able to access the Ross River for recreational activities after completion of the TPAR construction. Only vessels greater than 6m in height will be restricted entry to the river upstream of the bridge after completion of this access corridor. Fishing, picnicking and beach walking currently do not occur in the footprint of the other development projects occurring in the Townsville region and there are no anticipated cumulative impacts to the loss of these activities.

Coastal impacts of the proposed Precinct have been assessed under Section 3.8 of this EIS, a detailed report is provided as Appendix R. From that information it is known that the sand spit at the mouth of Ross River is highly mobile and changes shape according to seasonal and flood influences. This area is also currently utilised by all-terrain vehicles, including four-wheel drives and quad-motorbikes. Amphibious Army vehicles have also previously accessed the area. The mud / sand interface between the sand spit and mud flat area are also accessed and utilised by recreational fishers seeking bait for estuarine fishing. This practice occurs on an almost daily basis during calm fishing conditions. Thus, the sand spit does experience a degree of impact

despite its isolation from the road. Avoiding impact on this area for extractive activities will assist in maintaining recreational opportunities for fishers and beach visitation for a subset of the current recreational users of Lot 773.

Dog walkers and beach picnickers would not have ready access to the sand spit area and given the sensitive nature of bird communities using the area (refer Appendix V) this should not be encouraged. Potential for monitoring utilisation of the sand spit/mud flat area to determine whether use increases as a consequence of installation of the Precinct should be considered. Increased or changed utilisation may result in unfavourable impacts upon these preserved marine environments and the communities they support. Opportunities to mitigate against any increased impacts may include development of public education information regarding bird nesting and include exclusion of access to sites during critical nesting periods. Overfishing of bait species, such as yabbies (*Callianassa sp.*), that are currently sourced from this habitat may eventuate in self-regulation of this activity. Increased effort would likely reduce yield and result in recreational fishers sourcing their bait from other areas where greater return for fishing effort is achievable. Otherwise, if overfishing is noted to be reducing populations of bait species to non-sustainable levels, measures to manage influences may also need to be considered including public education approaches. Exclusion of access to the sand spit area during bird breeding season would provide a level of indirect protection to the bait species being targeted. These mitigation opportunities would need to be considered if cumulative/additional or changed impacts to the sand spit/mud flat area were detected as a result of removal of recreational opportunities currently associated with Lot 773.

Expected construction activity impacts identified above in Table 3-55 are likely possibilities under any of the other proposed adjacent projects. As a consequence, concurrent construction impacts in adjacent sites and, therefore, compounding of the identified impacts is also possible. Consistency in application of mitigation measures identified above should be considered for all other projects to reduce potential for cumulative impacts. In particular development of management plans for dredging, construction, waste management and hazardous material risks should be undertaken for the Marine Precinct such that the potential for cumulative effects, from other adjacent developments are considered and accounted for. This project, under identified mitigation strategies, is not expected to have any significant or long term negative impacts upon the ecological communities supported within this region.

3.10.6.7 Conclusion – aquatic ecology

The Precinct Project Area and adjacent areas include a number of key marine benthic habitats:

- The Marine Precinct Area is a shallow tidal sand/mud flat with small areas of intertidal beach, rocky foreshore and remnant natural vegetation;
- Seaward of the Marine Precinct Area is an extensive deepwater seagrass meadow;
- Up Ross River the eastern side remains fairly natural with small tributaries while the western side has been greatly modified, with rock walls and industrial development;
- At the mouth of the Ross River, the East Bank is a mud flat area that abuts fringing mangroves; and
- At the edge of this mud flat there is a highly mobile Sand Spit that changes shape according to seasonal and flood influences.

A range of communities were present across each of these habitats. The Marine Precinct Project area (Lot 773) supported a subtidal benthic community of relatively low diversity, with 25 species present. However the intertidal area was more diverse with 28 species recorded (there are usually many more benthic species present in subtidal soft bottom communities compared with intertidal communities).

The TMPP involves the construction of an industrial marine precinct about the mouth of the Ross River. Consequently the marine benthic habitats in this area will be markedly disturbed. Within the Townsville region a number of other construction projects are occurring that have the potential to result in compounding or cumulative impacts.

The main potential construction impacts, including potential cumulative impacts, that may result from the Precinct development include:

- Removal of benthic habitat,
- Declines in water quality associated with construction events; and
- Potential impacts to fauna, particularly marine megafauna, from vessel operations.

The main potential operational impacts from the Precinct development include:

- Continuous disturbance of benthic marine systems;
- Impacts to water quality;
- Impacts to marine megafauna from vessel operations; and
- Increased potential of pollution to the marine environment from changed use.

Proposed mitigation strategies against each impact were identified in the preceding section under Table 3-55. In brief, these include:

- Implementation and use of designated shipping channels and consideration of go slow zones to avoid impacting upon benthic taxa and mobile species, including megafauna;
- Use of appropriate facility design to minimise ongoing pollution potential, including from light spill and slipways;
- Implementation of waste management plans and provision of waste facilities;
- Implementation of hazardous material handling requirements and provision of access to appropriate emergency response kits;
- Extension of Ross River Channel to the outer extent of the breakwater, once it is constructed, with consequent extension of the 6 knot speed limit zone;
- Development and implementation of a dredge management plant to mitigate impacts on water quality; and
- Consideration of provision of public access facilities and public education material to mitigate against potential pollution and disturbance impacts.

Under appropriate management plans for vessel activity the Port of Townsville project is not expected to significantly impact on any of the NES, migratory or Other Protected Matter species that may potentially use the area. Although areas of seabed habitat will be removed under the immediate footprint of the Precinct, these community types are well represented in the area and within the region and long term impacts on the ecological value of the benthic communities of

Townsville are not expected. Habitat will also be created through development of the Precinct with interstitial rocky shore habitats being provided along the rock revetment walls and breakwater. Loss of seabed environs may be offset by the prawn farm restoration and the dedication of an Environmental Reserve on Port land on the eastern bank.

3.10.7 Marine megafauna

3.10.7.1 Overview of marine megafauna studies

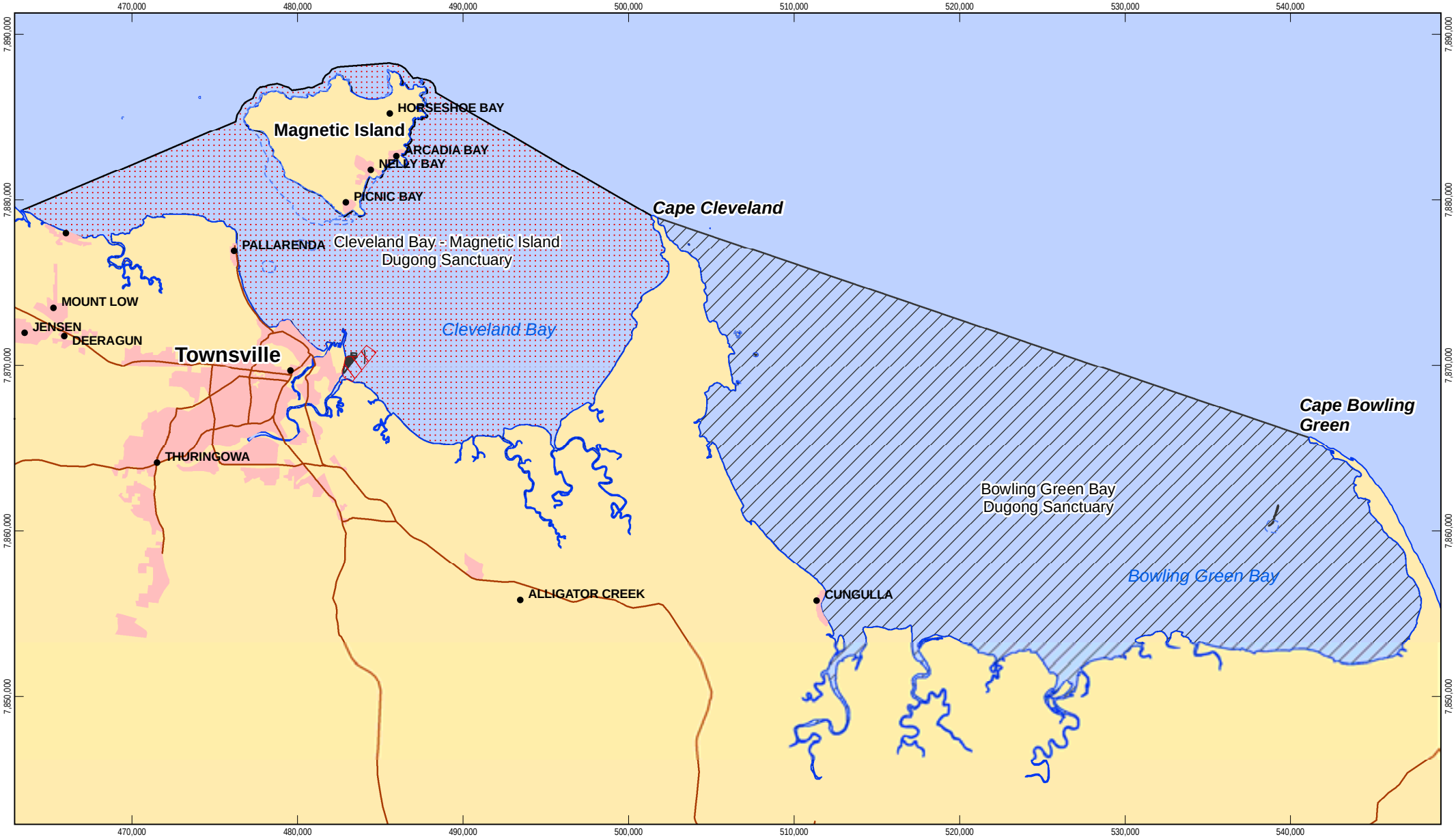
The coastal environment of northern Queensland supports numerous marine species that are vulnerable to anthropogenic impacts. Many key marine species in this area are of high conservation value and are afforded protection under State, National and International legislation and policy. (A summary of the legislation of relevance to marine megafauna is provided under Appendix U.)

The Precinct, located in the mouth of the Ross River, will be adjacent to Cleveland Bay, an area recognised to be of significant importance for a number of marine megafauna species, including turtle, dugong and dolphin. This is evidenced by the location of the site within a Species Conservation (Dugong Protection) Special Management Area ("Dugong Protection Area") (Figure 3-64).

Construction of the Precinct will remove an area of intertidal habitat and both construction and operation will change vessel usage patterns for the area. This has potential to impact upon these megafauna species. In recognition of this a targeted marine megafauna assessment study was completed.

The megafauna study collated information sourced through a focussed desktop assessment of available information (including Government agencies databases) and from the results of a marine megafauna habitat utilisation survey carried out to enhance and update existing knowledge of marine megafauna occurring within and adjacent to the Project Study Area.

This information is used to assess potential impacts to megafauna species from construction and operation of the Precinct and to derive mitigation strategies. The full report is detailed under Appendix U and summarised following.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

LEGEND

- Major Road
- Builtup Area
- Project Area of Interest
- Reefs and Shoals

Dugong Protection Area Type

- A
- B

Port of Townsville
Marine Precinct EIS

Job Number	42-15399
Revision	A
Date	01 July 2009

Dugong Protection Area in the Project Area

Figure 3-64

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3.10.7.2 Objectives and methodology – marine megafauna

The marine megafauna survey was undertaken over a seven month period from September 2008 – May 2009, and included three days of aerial surveys (two surveys per day, high and low tide) and seven monthly boat-based surveys (not including February and April). It noted that seasonality of species distribution in the Townsville region is not as influential on marine fauna distribution as other areas given that seagrass habitats remain relatively homogenous in standing crop throughout the year and Parra *et al* (2002) has observed no significant seasonality of dolphin presence. Marine turtles are likely to show an increase in presence leading up to the nesting period which has been captured in these surveys.

The main objective of the marine megafauna survey was to sample for the presence of key marine fauna species within the Project area and adjacent waters to enhance understanding of their habitat utilisation. This survey was designed and undertaken with key species specialists from the University of Queensland who have extensive experience in the Cleveland Bay region and are therefore able to provide independent evaluation of background information and survey results.

The survey design involved two components (aerial and boat-based surveys) that considered the behaviours of inshore dolphins, dugongs and marine turtle species that require frequent surfacing intervals. The surveys were conducted to enhance existing species distribution data at regional and finer spatial scales (Marsh and Sinclair 1989 a and b, Pollock *et al.* 2006, Lukoscheck and Chilvers, 2008, Chilvers *et al*. 2004, Groom *et al*. 2004; Parra *et al*. 2006).

3.10.7.3 Survey Design

Boat-based sampling

The boat-based survey was carried out according to a stratified design across a variety of depths taking into consideration habitat information from existing epi-benthic habitat mapping (Rasheed *et al.* 2008) and known marine turtle distribution in Cleveland Bay (pers comm., Ian Bell; DERM 2009). Each monthly sample comprised 22 spot sampling sites, four transects of approximately six km in length and a further five transects broken by the spot sampling sites. This mix of point and transect sampling was determined as the best method to capture the diversity of species in the Project area within a limited time frame, based on experience in other areas (Southern Moreton Bay, Abbot Point, Gladstone). Transects were undertaken at a steady speed of approximately 10 – 12 km/hr.

This design has the advantage of covering the heterogenous and patchy habitat in the port environment over a period of time which is not viable for aerial surveys; this increases the theoretical detectability of species which must surface to breathe, and permits a targeted survey area of known marine fauna habitat. For this multi-species survey, monthly surveys were necessary as most species will exhibit a degree of seasonality, or emigration and reimmigration in their movements over time.

Dugongs spend less than 2% of their time at the surface of the water and often surface cryptically (Anderson 1985; Churchward 2001). A 10 minute observation period for spot sampling was chosen because 90% of dugong dives are less than five minutes duration and dives greater than 10 minutes are very uncommon (Chilvers *et al.* 2004). Similarly, green turtles (*Chelonia mydas*) have recorded mean foraging dives of 4.5 mins (Rice *et al.* unpublished

data). Cetaceans are also observed to surface regularly and have successfully been surveyed by undertaking boat-based transects (Lukoscheck and Chilvers 2008; Parra *et al.* 2006; Skrovan *et al*., 1999 and Stacey 1996).

Under good weather conditions (< 15 knots), boat-based spot sampling sites enable a sighting radius of approximately 200 m from the boat for surfacing megafauna with the exception of whales, which are clearly observed from distances over 500 m. Sighting distance is dependent upon sea state and weather conditions as a result, an approximate distance of 200 m is given as the maximum distance of detection at any given survey time. This distance increases greatly with favourable weather conditions and declines consequently with increased swell or wind affected sea surfaces. Figure 3-65 depicts the survey sites undertaken each month where red dots represent spot sampling sites and the red lines represent transects.

During the 10 minute spot sampling, experienced observers are positioned facing the bow and stern of the vessel with each observer scanning 180^0 this provides a combined search area of approximately 0.125 km^2 (x 22 sites). The following information is recorded:

- G.P.S location;
- Time and date;
- Depth;
- Species and number of individuals; and
- Age class of species (where discernable).

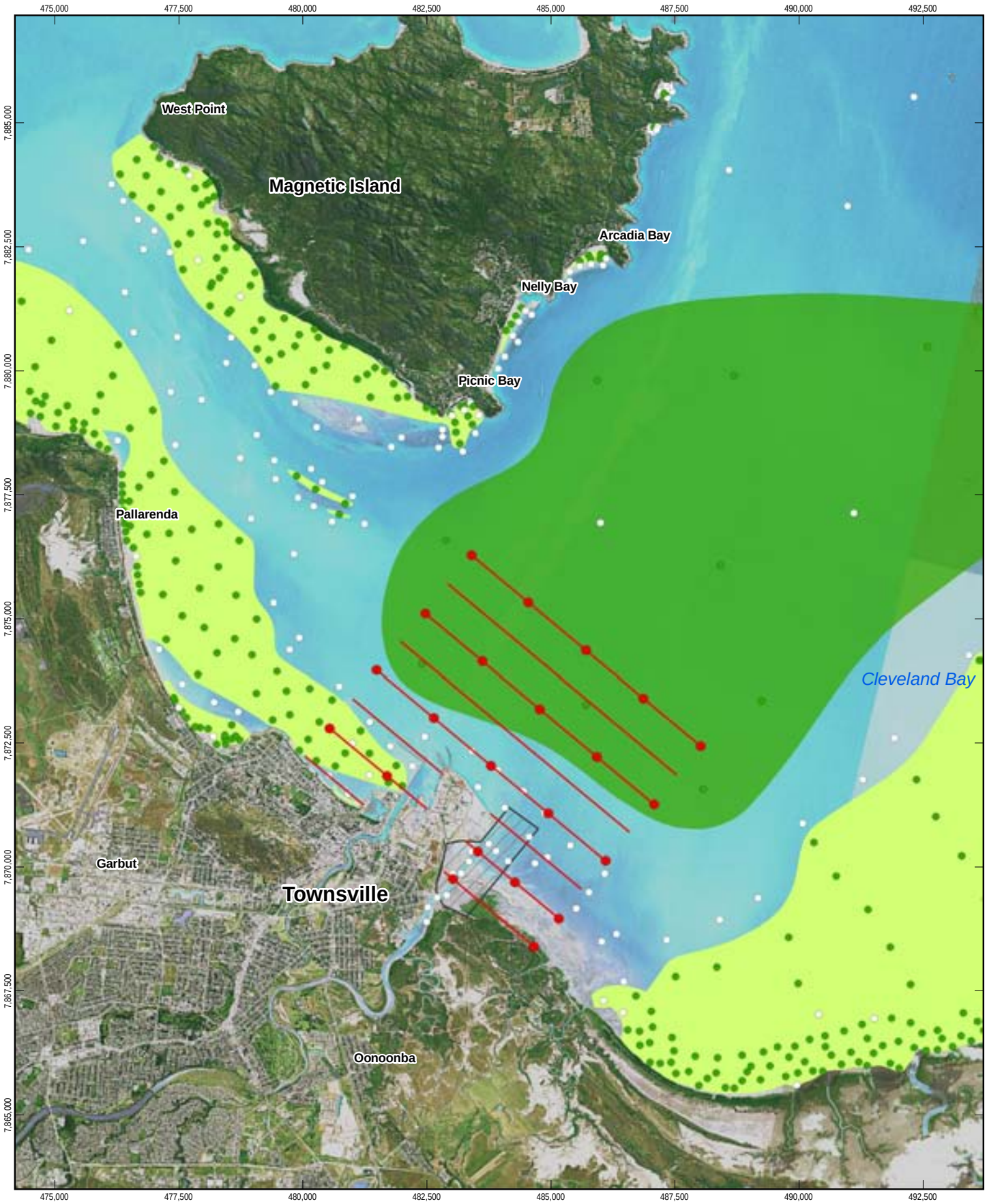
Species age class was defined as per Table 3-56.

Over the seven boat-based survey periods (September 2008 – May 2009, excluding February and April) approximately 48 km of transects were sampled, and 220 minutes of spot sampling carried out within the Project area. The sampling of sites was dependent upon tidal state, so that shallower sites (< 3 m) were sampled at high tide to account for animals that may be accessing food resources that would otherwise be tidally restricted. The surveys used a 6 m rigid boat with a high canopy where an observer could sit to improve the vantage point.

Table 3-56 Age class categories for green Turtle, the dugong and inshore dolphin species

Species	Age class	Size (curved carapace length for turtles)	Age range (years)
Green turtle (*Chelonia mydas*)	Adult	85 – 120 cm	32 +
	Subadult	65 – 90 cm	18 – 35
	Juvenile	40 – 65 cm	5 – 18
Dugong (*Dugong dugon*)	Adult	240 – 300 cm	6 - 70 +
	Calf	100 cm – 200 cm (closely associated with adult)	0.1 – 1.5
Indo-Pacific humpback dolphin *(Sousa chinensis)*	Adult	200 – 320 cm	
	Juvenile	150 – 200 cm	
	Calf	100 cm – 200 cm (closely associated with adult)	
Snubfin dolphin (*Orcaella heinsohni*)	Adult	200 – 275 cm	
	Juvenile	150 – 200 cm	
	Calf	<100 cm – 200 cm (closely associated with adult)	

Source: Adapted from - Chaloupka and Limpus, 2005, Marsh 2004, Jefferson *et al.* 1993



LEGEND

- Marine Megafauna Spot Sample Locations
- Marine Megafauna Transect Lines
- Project Area of Interest
- Coastal & Deepwater Biomass Sites 2007
  - Sites without seagrass
  - Sites with seagrass
- Coastal Seagrass Meadows 2007
- Deepwater Seagrass Meadows 2007

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

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Port of Townsville
Marine Precinct EIS

Job Number 42-15399
Revision A
Date 01 July 2009

Proposed Marine Megafauna Survey Locations

Figure 3-65

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

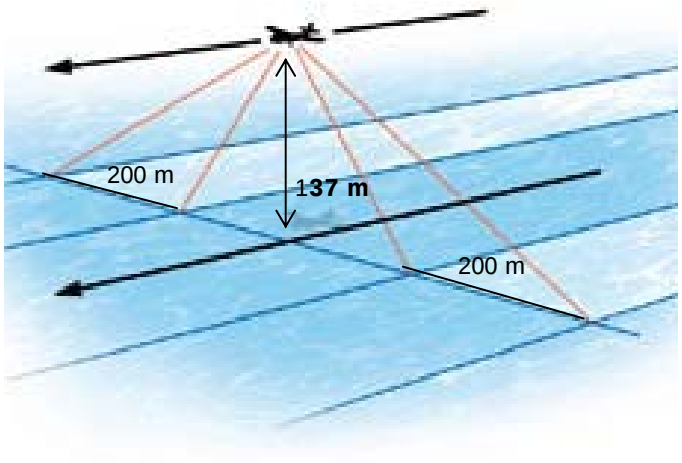
Aerial survey

The aerial survey was undertaken using a methodology adapted from Marsh and Sinclair (1989 a and b) and Pollock (*et al* 2006), which has been used to survey the entire Queensland coast for marine megafauna over several years. Aerial surveys used a high-wing twin-engine Partenavia 68B with survey markers attached to struts, which were fitted to the wings for this purpose.

Aerial transects were designed by Dr Hodgson of the University of Queensland to survey the whole bay, with a more intensive survey block around the Marine Precinct area. The aircraft flew along predetermined transects at a ground speed of 100 knots and at a height of approximately 450 ft or 137 m.

Two trained and experienced observers counted dugongs and other marine wildlife within a strip of sea defined by marker rods attached to 'pseudo wing struts'. The strip thus demarcated on either side of the aircraft is 200m wide when the aircraft is flying at the nominal height (137m) (Figure 3-66).

Figure 3-66 Aerial survey flight parameters



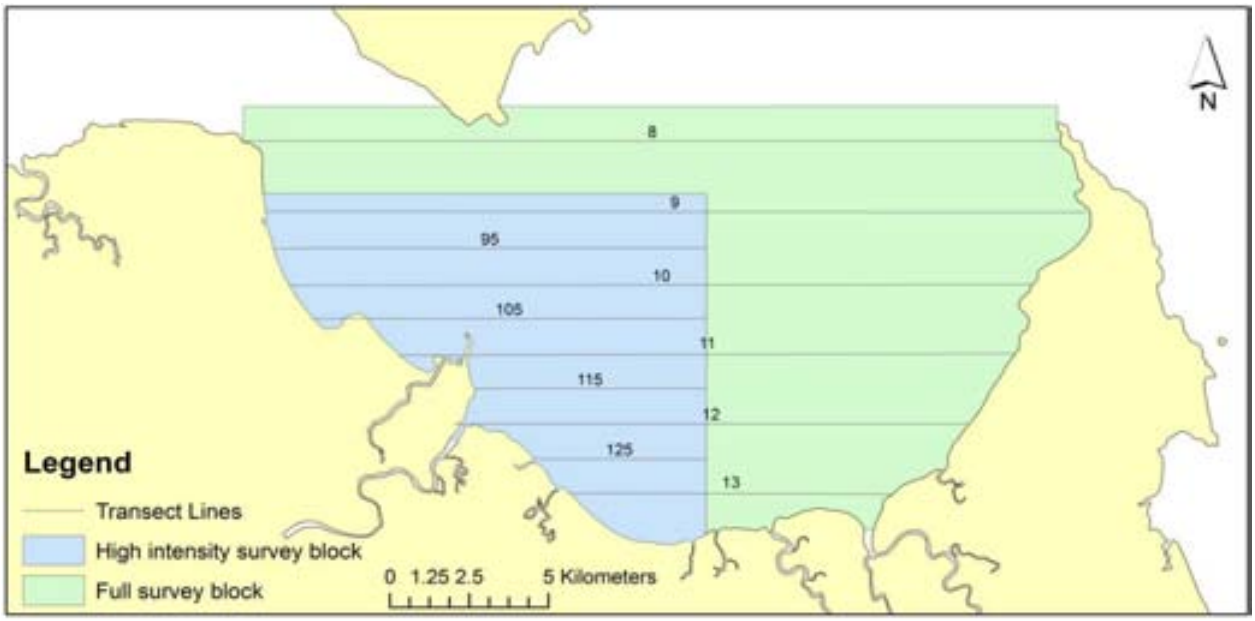
(Source: Hodgson *et al.* 2007)

Observers communicated with the survey leader at the front of the plane via an intercom system linked to a digital audio recorder. Information was recorded by the survey leader using a pocket computer programmed as a data logger and synchronised to a GPS. A micro-track digital voice recorder was also used for recording sightings and as back-up. The observer on each side scanned the transect on their side of the aircraft. The intercom tape recorder recorded all observations voiced by the survey team.

The survey area was divided into two blocks, the full survey area, and a higher intensity survey area that contained the region of the proposed Marine Precinct site (Figure 3-67). Transects were 2.5 nm apart for the full survey area, and 1.25 nm apart for the high intensity block adjacent to the TMPP. The population estimate calculated for the full survey block included only transects that spanned the whole survey area (i.e., transects 8, 9, 10, 11, 12, 13), while the high intensity block included the additional short transects (95, 105, 115, and 125) together with

transect 9-13 truncated at the eastern edge of this block. The sampling intensity for the full survey block was 17.8% and for the high intensity block was 34.4%.

Figure 3-67 Transects in Cleveland Bay for the aerial survey



3.10.7.4 Description of environmental values – marine megafauna

Knowledge from Database Searches

A search of the Commonwealth EPBC Protected Matters online search tool revealed 21 listed marine fauna species that occur or have the potential to occur in proximity to the Precinct area. Table 3-57 lists each of these species, their current conservation status with respect to State (NCA) and National (EPBC) legislation, and their likelihood of occurrence within the Project area. These species are considered vulnerable as they are long-lived and slow-growing with a low rate of fecundity. For each of these species, their ecology, distribution and population potentially affected by the Precinct is summarised in Appendix U.

Cleveland Bay is recognised to be of importance for the Australian snubfin and Indopacific humpback dolphin, for dugongs and for a range of marine turtles. Along the urban coast of Queensland dugongs mostly occur in large, northward facing bays, including Cleveland Bay, that are sheltered from the prevailing southeast winds. These bays support the most seagrass along this coastline (Marsh *et al*. 2002) (Figure 3-68). The waters adjacent to the TMPP have also been recognised as an important habitat for Australian snubfin (*Orcaella hinsohni*) and Indo-Pacific humpback (*Sousa chinensis*) dolphins (Parra *et al*. 2006) (refer Figure 3-69).

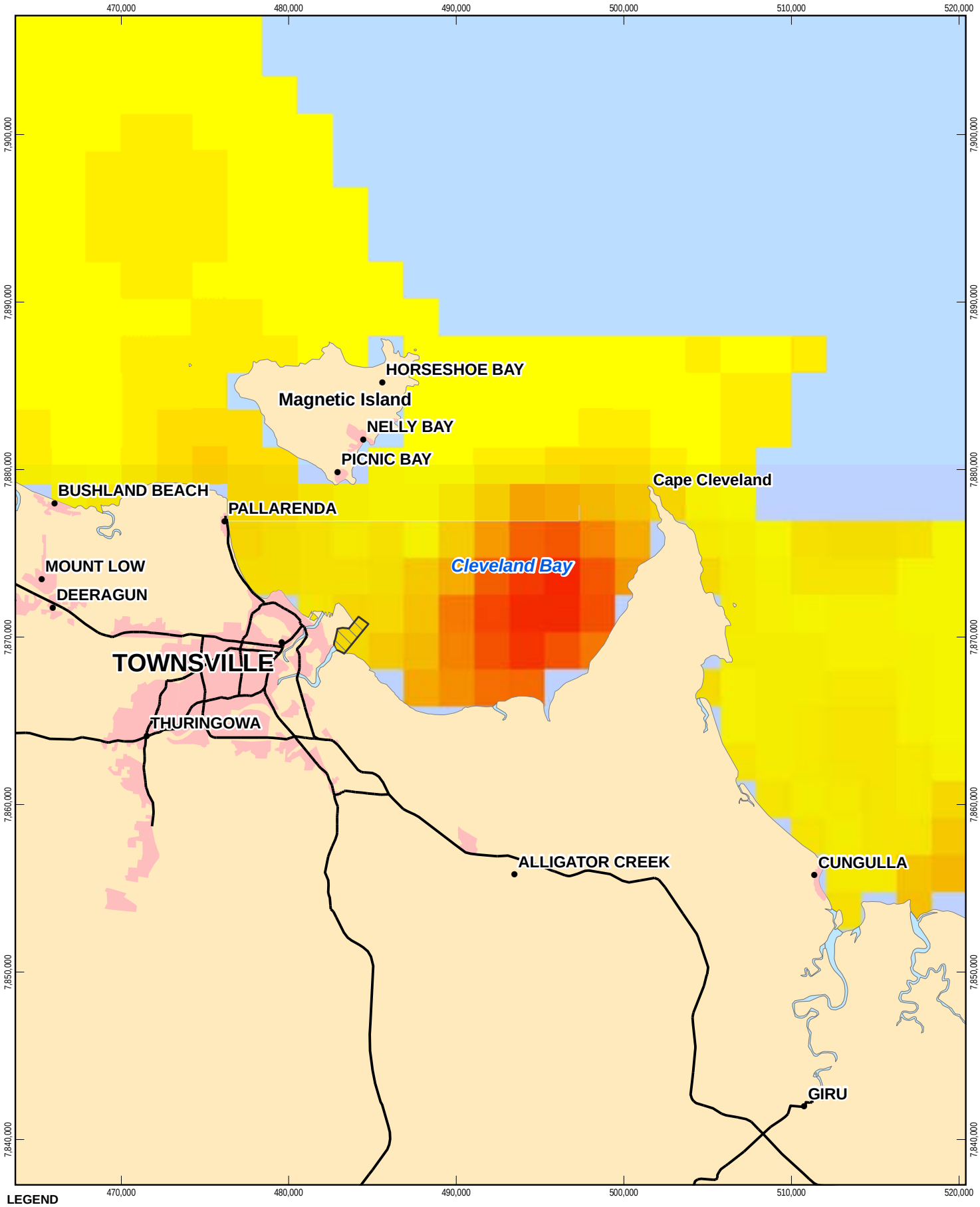
Table 3-57 Listed Marine Fauna potentially found within the Project area

Scientific Name	Common Name	EPBC	NCA	IUCN (World Conservation Union)[1]	Likely Occurrence within the Project area
Marine mammals					
Megaptera novaeangliae	Humpback whale	Vulnerable, Migratory (Bonn), Cetacean	Vulnerable	Least Concern	Possible
Marine reptiles					
Natator depressus	Flatback turtle	Vulnerable, Migratory (Bonn), Marine	Vulnerable	Data Deficient	Possible
Chelonia mydas	Green turtle	Vulnerable, Migratory (Bonn), Marine	Vulnerable	Endangered	Possible
Caretta caretta	Loggerhead turtle	Endangered, Migratory (Bonn), Marine	Endangered	Endangered	Possible
Lepidochelys olivacea	Olive ridley turtle	Endangered, Migratory (Bonn), Marine	Endangered	Vulnerable	Possible
Eretmochelys imbricata	Hawksbill turtle	Vulnerable, Migratory (Bonn), Marine	Vulnerable	Critically Endangered	Possible
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory (Bonn), Marine	Endangered	Critically Endangered	Unlikely
Threatened sharks					
Pristis zijsron	Green sawfish	Vulnerable		Critically Endangered	Unlikely
Rhincodon typus	Whale shark	Vulnerable, Migratory (Bonn)		Vulnerable	Unlikely
Migratory marine mammals					
Balaenoptera edeni	Bryde's whale	Migratory (Bonn), Cetacean		Data Deficient	Unlikely
Orcaella heinsohni	Australian snubfin dolphin	Migratory (Bonn), Cetacean	Rare	Near Threatened	Likely

Scientific Name	Common Name	EPBC	NCA	IUCN (World Conservation Union)[1]	Likely Occurrence within the Project area
Sousa chinensis	Indo-Pacific humpback dolphin	Migratory (Bonn), Cetacean	Rare	Near Threatened	Likely
Orcinus orca	Killer whale	Migratory (Bonn), Cetacean		Data Deficient	Unlikely
Migratory Marine Reptiles					
Crocodylus porosus	Estuarine crocodile	Migratory (Bonn), Marine	Vulnerable	Lower Risk/least concern	Possible
Listed Cetaceans					
Balaenoptera acutorostrata	Minke whale	Cetacean		Least Concern	Unlikely
Delphinus delphus	Common dolphin	Cetacean		Least Concern	Unlikely
Grampus griseus	Risso's dolphin	Cetacean		Least Concern	Unlikely
Stenella attenuata	Spotted dolphin	Cetacean		Least Concern	Unlikely
Tursiops aduncus	Indian Ocean bottlenose dolphin	Cetacean		Data Deficient	Possible
Tursiops truncatus	Bottlenose dolphin	Cetacean		Least Concern	Possible
Threatened Species Potentially Occurring					
Dugong dugon	Dugong	Migratory, Marine	Vulnerable	Vulnerable	Likely

[1] IUCN Red List categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient (Source: 2002 IUCN Red List of Threatened Animals).

Cleveland Bay is not recognised as a major nesting area for marine turtles along the Queensland coast, however, low density nesting by green and flatbacks does occur. Cleveland Bay is recognised as an important foraging habitat for green turtles (Figure 3-70). In a regional context, Halifax, Cleveland and Bowling Green Bays are all important feeding sites where green turtles graze on the seagrass beds and flatback and loggerhead turtles forage for invertebrates (pers comm. I. Bell, DERM 2008). Hawksbills are found on the inshore reefs and the olive ridley can be found in the deeper waters around Magnetic Island and along the coast. Leatherbacks are rarely sighted off Townsville, and then only in deeper waters. Collectively, these areas form an important part of Queensland's sea turtle habitat.



LEGEND

Major Road | Project Area of Interest | Builtup Area | Relative Dugong Density: High : 10 — Low : 0.01

1:300,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Model of dugong relative density and distribution in Cleveland Bay, Queensland

Job Number	42-15399
Revision	A
Date	01 July 2009

Figure 3-68

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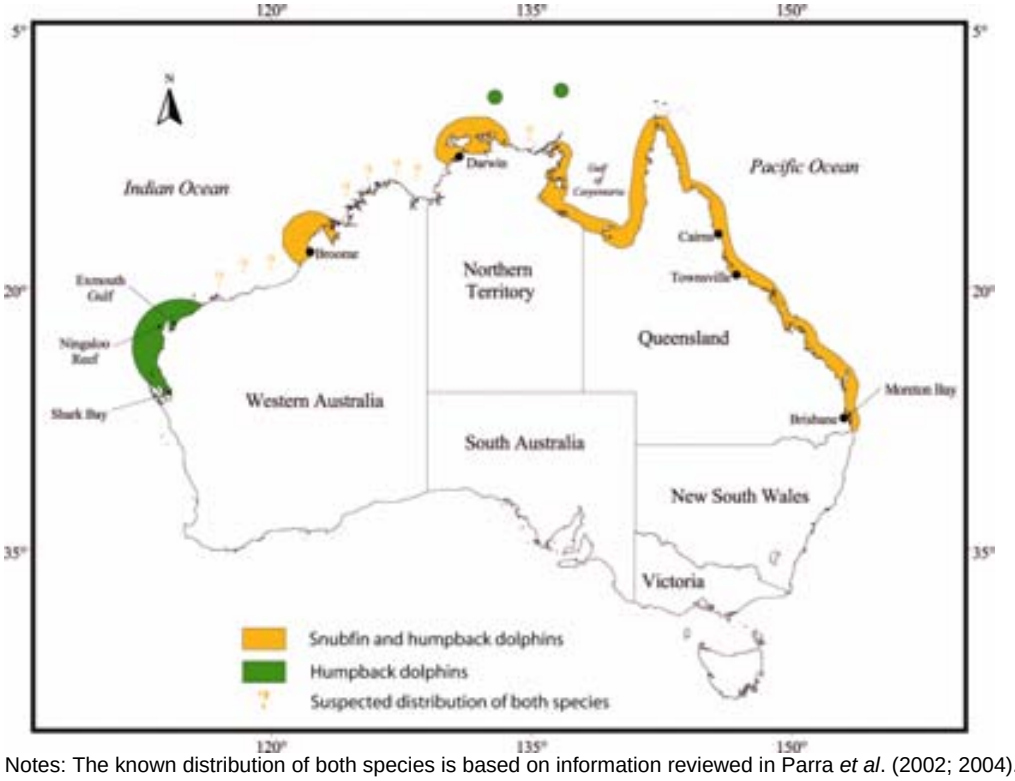
Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

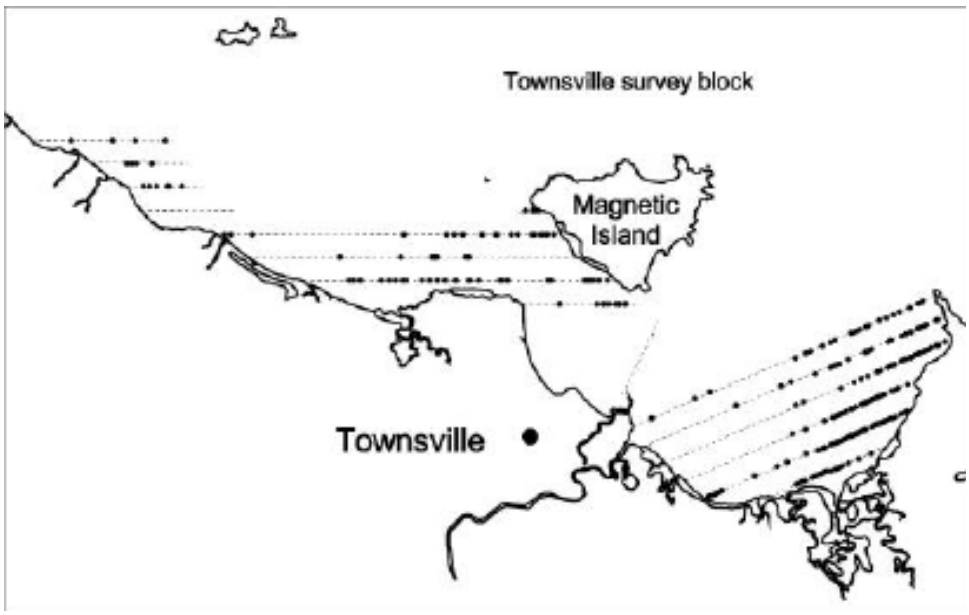
Data source: Dugong Density - Grech. A., and Marsh. H. (2007). Prioritising areas for dugong conservation in a marine protected area using a spatially explicit population model, Applied GIS, 3(2), 1-14; Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; 250K Topo Data - ©Commonwealth of Australia (Geoscience Australia) 2007. Created by: TH

Figure 3-69 Distribution of snubfin and humpback dolphins in Australian waters



Notes: The known distribution of both species is based on information reviewed in Parra *et al*. (2002; 2004). Question marks indicate areas of probable, but unconfirmed, distribution

Figure 3-70 Marine turtle aerial survey observations in Cleveland Bay



Field Result Findings

The aerial and boat-based survey results are consistent with current literature that acknowledges the importance of Cleveland Bay as a key habitat area for significant marine fauna species. The surveys identified a range of age classes using Cleveland Bay.

Megafauna species identified on boat-based and aerial surveys include:

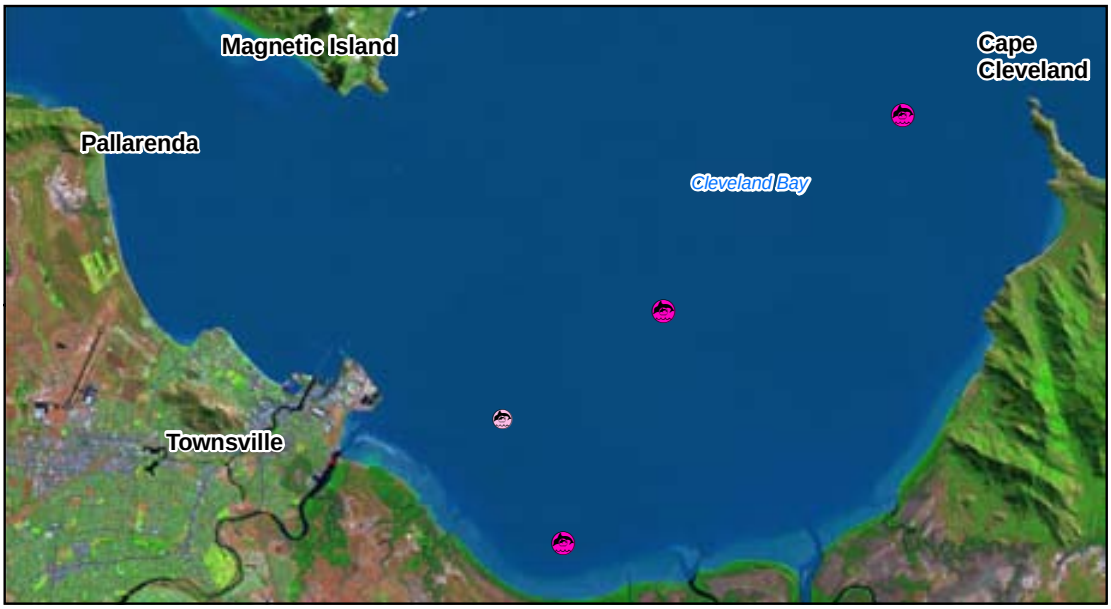
- Marine turtles (majority of observations were green turtle, *Chelonia mydas*) *N* = 27;
- Dugong (*Dugong dugon*) *N* = 32;
- Australian snubfin dolphin (*Orcaella heinsohni*) *N* = 2 (adult and calf);
- Indo-Pacific humpback dolphins (*Sousa chinensis*) *N* = 6;
- Bottlenose dolphins (*Tursiops spp*.); *N* = 2;
- Sharks, rays and a seasnake; and
- Unknown dolphin species *N* = 1.

N= maximum number of individuals recorded for each species in one sampling effort (aerial or boat-based)

The larger spatial scale survey identified areas within Cleveland Bay of high value to dugong and marine turtles with numerous animals identified in the eastern part of Cleveland Bay associated with known seagrass habitats (Figure 3-71). Three dolphin species were also recorded in areas previously identified as representing preferential Indo-Pacific humpback dolphin habitat.

The finer spatial scale survey identified use of habitat in close proximity to the Precinct by Indo-Pacific humpback dolphins, Australian snubfin dolphins, dugong and green turtles (Figure 3-72).

None of the key marine fauna species (dugong, marine turtle and dolphins) surveyed were observed within the immediate footprint of the Marine Precinct, although they were in close proximity (< 2 km). This was expected as the Precinct is a shallow tidal sand/mud flat which does not support preferential feeding or nesting habitat. Parra (2006) observed snubfin dolphins concentrating their activity around two areas northwest of Cape Pallarenda, and south around Townsville's Port and Ross River mouth. Humpback dolphins show a similar distribution concentrating their activities mainly around the dredged channels and breakwaters close to the Port of Townsville, without a clear seasonal pattern (Parra 2006). Similarly, this survey recorded observations of both snubfin and humpback dolphins sharing the habitat around the Townsville port and Ross Creek mouth. It is expected that these key marine fauna species have a higher presence in areas of important habitat i.e. in close proximity to the port and seagrass meadows, though the requirement to transit between habitat patches needs to be acknowledged. As the whole bay is representative of important habitat it is necessary to consider movements when assessing potential impacts on migratory species (Grech and Marsh, 2007).



1:200,000 (at A4)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Job Number	42-15399
Revision	A
Date	01 July 2009

All Dugong, Dolphin and Turtle Observations from Aerial Surveys

Figure 3-71

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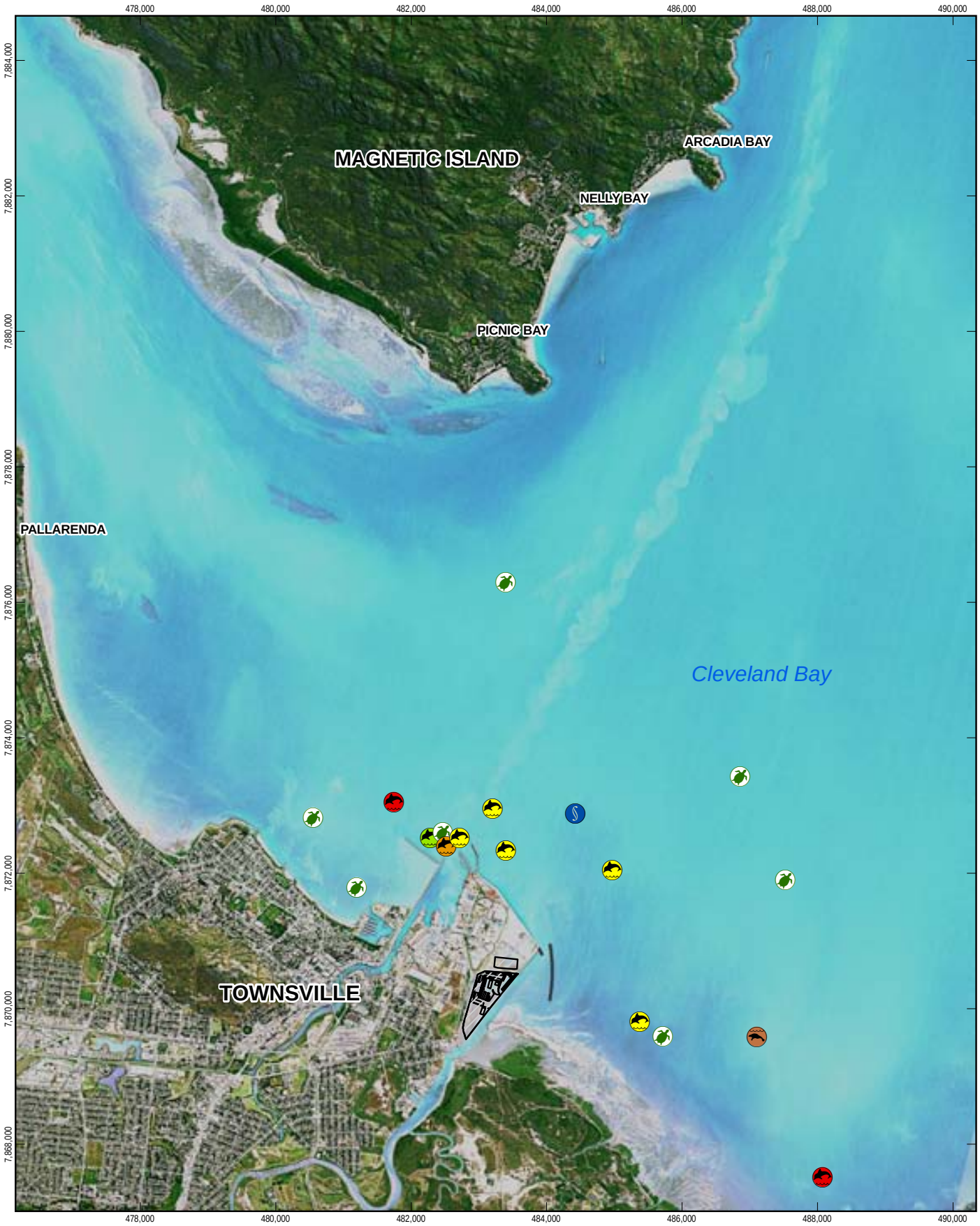
Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Landsat image - ©The State of Queensland (Department of Environment and Resource Management); 250K Topo Data - ©Commonwealth of Australia (Geoscience Australia) 2007. Created by: TH



LEGEND

- Australian Snubfin Dolphin
- Indo-Pacific Humpback Dolphin
- Bottlenose Dolphin
- Unknown Dolphin Species
- Dugong
- Turtle
- Sea snake
- Proposed Marine Precinct
- Breakwater Option

1:75,000 (at A4)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

Port of Townsville
Marine Precinct EIS

Marine Fauna Sightings during Boat Surveys

Job Number	42-15399
Revision	B
Date	01 July 2009

Figure 3-72

G:\42\15399\GIS\Projects\EIS\42-15399_218_rev_b.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 4496 **F** +61 7 3316 333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: Marine Precinct - ©The State of QLD (Port of Townsville LTD) 2009; Aerial (flown 2004) - ©The State of Queensland (Department of Environment and Resource Management); 250K Topo Data - ©Commonwealth of Australia (Geoscience Australia) 2007. Created by: TH

Seagrass distribution in the bay is broadly similar between seasons and covers the majority of port limits with 14,338 and 14,004 ha mapped in the wet and dry season respectively (Rasheed and Taylor, 2008). This suggests that given the dependence of dugong and green turtles on seagrass as a resource, their presence in Cleveland Bay would remain relatively unchanged throughout the year.

With respect to species distribution recorded on this survey and in previous years, the construction of the Marine Precinct by the Port of Townsville is not expected to have a significant impact on the key marine megafauna species, either in terms of direct impacts to important habitat, or disruption of transit routes between habitat patches. The construction phase of the Precinct is likely to impose a temporary increase in vessel traffic at the Ross River mouth. These vessels are likely to be slow-moving dredgers, which are of some concern to marine turtles that are known to rest on benthic habitats. Commercial vessels likely to utilise the Precinct already operate within the existing Ross River channel accessing upstream facilities that will be relocated into the Precinct. No new recreational boat ramps are planned as part of the Precinct and, accordingly, no increase in vessel access is anticipated. If additional recreational boating facilities are proposed for the Ross River in future site assessment studies would need to address potential impacts of that increased vessel traffic on megafauna. In order to assess the impacts and mitigation measures appropriate to avoid impacts likely from construction and operation of the TMPP on marine megafauna in the areas associated with development and operation of the Precinct, an impact and risk assessment has been undertaken and is described in the following section. This risk assessment follows methodology described under Section 3.10.2.

3.10.7.5 Potential impacts and mitigation measures – marine megafauna

Marine megafauna are subject to numerous anthropogenic impacts given their association with coastal habitats. Appendix U discusses threats to marine megafauna in the Cleveland Bay area. These threats and impacts are also discussed with respect to the proposed Marine Precinct development. Potential impacts are summarised following.

The TMPP will have a number of permanent impacts on the marine ecological values of the area in which it is located. The majority of the impacts comprise the removal of an area (approximately 32 ha) of intertidal sand/mud flat on the western bank of the Ross River that forms Lot 773. Further, the loss of seabed associated with the footprint of the breakwater (approximately 2 ha in total) will also occur. In addition, a range of temporary impacts are expected as a result of construction activities, including dredge plume impacts and noise impacts.

No removal of seabed or disturbance of marine habitats is proposed for the eastern bank area of the Ross River, across from the Lot 773 footprint. Prior to the construction of the Precinct a road and rail link to the proposed port site will be constructed. This road and rail corridor will enter the port site from the east, passing through the land on the eastern side of the Ross River mouth and crossing Ross River to the south of Lot 773. The actual design and construction of this infrastructure is the subject of another EIS by the Department of Main Roads. A range of cumulative impacts may occur in regards to construction effects on marine megafauna species and removal of benthos.

With respect to key marine fauna species, the impacts expected to result from the Marine

Precinct project, either during construction and/or operation, include:

» Direct impacts (both potential and probable);
  – Removal of potential foraging habitat for some marine turtle species; loggerhead and olive ridley (neither species recorded on survey (turtles not identified to species level on aerial surveys) though identified as potentially occurring from desktop survey);
  – Damage/mortality to individual animals from direct contact related to construction activities;
  – Impact to fauna by boat strike;
  – Lighting impacts to nesting turtles and hatchlings in the Townsville region (November – April);
  – Disturbance and displacement from increased noise and/or activity during construction on the local area;
  – Increased rubbish that may be ingested or entangle marine fauna;
  – Decreases in water quality from dredging, construction, spills of fuel or other hydrocarbons, paint, animal waste (feline pathogens) - feral or domestic, solvents and cleaners.
» Indirect impacts (both potential and probable);
  – Decreased water quality from construction disturbance of sediments around the Precinct site;
  – An increase in sedimentation that may result in the smothering of adjacent benthic habitat communities;
  – Degradation of habitats through continual human usage (including inappropriate waste management, boat fuel spills);
  – Decreased water quality resulting from inappropriate waste management or an increase in sediments and pollutants as a result of construction waste or land use changes; and
  – Noise and vibration impacts to marine fauna from in-water construction or ongoing operational activities.

Reduced use of the area by migratory marine megafauna may occur as a consequence of these potential impacts. This may have flow on effects for the value of the marine ecosystems within the Townsville region. To address this, an assessment of the risk of each impact and mitigation measures is provided below in Table 3-58.

Table 3-58 Risk assessment for marine megafauna

Activity	Expected impact	Preliminary risk assessment (L,C) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (L,C) Score
Construction Works				
Pile driving, dredging and general construction in water	Increased sedimentation in the Ross River, declines in water quality, potential displacement of marine megafauna in the local area.	(4, 4) 16 High	Consideration of use of sediment / silt mitigation devices like silt curtains as appropriate for construction/dredge methodology. Consideration of timing of dredging activity to not coincide with rough weather that would exacerbate impacts. Implement construction and dredge management plans including approaches to hopper de-watering, overflow, monitoring of water quality conditions and use of water quality triggers to halt dredging if unacceptable decline in water quality detected.	(2, 4) 8 Medium
	Acoustic impacts, interference with communication of marine fauna leading to temporary avoidance or displacement.	(2, 4) 8 Medium	Use of warning strikes pre full drive of pile (if found to be effective). Implement a megafauna management plan. Consider undertaking a desktop and field assessment of sound propagation in the Townsville Port region. Consider use of a megafauna spotter on vessel to manage conduct of activity when animals less than 50 m from vessel.	(1, 4) 4 Medium
	Direct impacts by dredge plant on marine megafauna leading to temporary displacement or	(3, 3) 9 Medium	Maintain visual check for megafauna activity in path of dredger and consider operational avoidance measures to reduce risk of impacting turtles, particularly within 50 m of operations.	(2, 3) 6 Medium

Activity	Expected impact	Preliminary risk assessment (L,C) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (L,C) Score
	mortality.		Use bucket dredge (backhoe). If possible, use of trailer suction dredge should include turtle exclusion devices like tickler chains. Do not start dredging operation until dredger head is on the seabed. Implement a megafauna management plan to mitigate impacts.	
Light spill from construction plant	Disorientation by nesting or hatchling marine turtles leading to inappropriate clustering of fauna to construction site.	(2, 3) 6 Medium	Install lighting that includes reduced risk of spill into marine environment through use of light screens. Consider lighting options and safety needs and use most appropriate wattage / lighting type for minimising impact on marine taxa. Use limited lighting adjacent to water. Adopt timed lighting to minimise light pollution. As no turtle nesting has been observed within immediate vicinity, monitoring of turtle nesting behaviour is not considered relevant, though consideration is given to hatchling dispersal and Precinct lighting as noted above.	(1, 3) 3 Low
Increased occurrence of rubbish from construction activities	Waste materials, domestic rubbish enter marine environment and smother benthic habitats, ingested by marine fauna leading to death or illness.	(3, 3) 9 Medium	Implement waste management plans and measures including provision of solid waste containers for recycling or disposal of via a licensed contractor. Educate onsite users of facility in regards to appropriate waste management requirements.	(2, 2) 4 Low
Increased vessel traffic (construction vessels)	Increased boat strike of or interaction with marine fauna	(3, 2) 6 Medium	Provide education and training to vessel operators in regards to monitoring for and management of interactions with marine fauna.	(2, 2) 4 Low

Activity	Expected impact	Preliminary risk assessment (L,C) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (L,C) Score
	leading to death or injury. These vessels are likely to be slow-moving dredgers, which are of some concern to marine turtles that are known to rest on benthic habitats.		Implement fauna spotting and appropriate avoidance measures whilst dredging to reduce risk of impacting turtles. Consider working with regulatory agencies to implement Go Slow Zones in Port vicinity and over adjacent shallow foraging habitats.	
Habitat removal as result of construction and dredging activities for both Precinct and breakwater facility	Benthic marine habitat, inter and subtidal, removed potentially removing habitat for marine megafauna prey items.	(5, 1) 5 Medium	Implement a dredging and spoil disposal management plan considering avoidance of marine habitats used frequently by marine megafuna. Implement a construction environmental management plan. Consider offsetting impacts from benthic habitat removal by remediating or rehabilitating other degraded environs.	(5, 1) 5 Medium
	Reduced water quality from construction and dredging activities providing indirect impact on marine fauna leading to illness or death.	(3, 3) 9 Medium	Implement construction and dredge management plans including approaches to hopper de-watering, overflow, monitoring of water quality conditions in impact site as and adjacent waters and use of water quality triggers to amend dredging approach (eg consider introducing silt curtains to the extreme of halting dredging) if unacceptable decline in water quality detected.	(2, 3) 6 Medium
	Increased potential for fuel, hydrocarbon, chemical (etc) spill during construction activities.	(4, 3) 12 High	Identify hazardous material handling requirements and implement waste management and emergency response	(2, 3) 6 Medium

Activity	Expected impact	Preliminary risk assessment (L,C) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (L,C) Score
			procedures. Suitable and sufficient oil and chemical spill response equipment to be available and easily accessible. Training in spill response and reporting to be undertaken.	
	Habitat loss and degradation resulting in displacement of snubfin and humpback dolphins from core habitats identified around the Port of Townsville and Ross River mouth	(1, 5) 5 High	Development of an impact management plan for coastal dolphins pre, during and post construction.	(1, 5) 5 High
Operational Works				
Operation of Precinct facility	Alteration of local hydrodynamics and potentially altered use by marine fauna.	(2, 5) 10 High	Adopt design configuration to minimise impacts on hydrodynamics.	(1, 5) 5 High
	Acoustic impacts, interference with communication of marine fauna leading to temporary avoidance or displacement.	(2, 4) 8 Medium	Facilitate construction to consider design strategies for in-water noise reduction. Like facilities exist in Ross River currently and fauna currently use area.	(1, 4) 4 Medium
	Creation of inner harbour habitat, increase in potential prey items and area for utilisation by marine megafauna.	Positive benefit	Provides benthic habitat that can be recolonised by taxa and provide a potential foraging and resting site for marine megafauna.	Positive benefit

Activity	Expected impact	Preliminary risk assessment (L,C) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (L,C) Score
Increased occurrence of rubbish in local area	Waste materials, domestic rubbish, enters marine environment and smother marine systems, ingested by marine fauna leading to death or illness. Pet waste (pathogens) enters marine environment, leading to illness or death in marine megafauna.	(3, 4) 12 High	Implement waste management plans and measures including provision of solid waste containers for recycling or disposal of via a licensed contractor. Educate onsite users of facility in regards to appropriate waste management requirements. No pets permitted on site.	(1, 4) 4 Medium
Light spill from Precinct Facilities	Disorientation by nesting and hatchling marine turtles leading to inappropriate clustering of fauna to Precinct site.	(2, 5) 10 High	Install lighting that includes reduced risk of spill into marine environment through use of light screens. Consider lighting options and safety needs and use most appropriate wattage / lighting type for minimising impact on marine taxa. Use limited lighting adjacent to water. Adopt timed lighting to minimise light pollution. As no turtle nesting observed within vicinity monitoring of turtle nesting behaviour not considered relevant.	(1, 5) 5 High
	Increased potential for fuel, hydrocarbon, chemical (etc) spill during operational activities.	(3, 4) 12 High	Facilities to be designed to standards to mitigate pollution potential. Identify hazardous material handling requirements and implement waste management and emergency response procedures. Suitable and sufficient oil and chemical spill response equipment to be available and easily accessible. Training in spill response and reporting to be undertaken.	(2, 4) 8 Medium

Activity	Expected impact	Preliminary risk assessment (L,C) Score	Standard Mitigation Measures	Residual Risk with Precautionary Measures Adopted (L,C) Score
Vessel traffic	Perceived increased risk of boat strike to marine fauna leading to death or injury. Vessel traffic is likely to remain at levels similar to present as no additional vessel accommodation is provided. Vessel traffic may at present temporarily displace dolphins from core habitats around the port of Townsville and Ross River mouth or disturb foraging behaviour in areas adjacent to the port of Townsville.	(3, 4) 12 High	Provide education and training to Precinct operators in regards to monitoring for and management of interactions with marine fauna. May include public education information provisions waterside. Provide designated shipping channels and go slow (6 knots) areas to decrease probability of collision. Work with regulatory agencies to implement Go Slow Zones in the Port vicinity and over shallow foraging habitats.	(2, 3) 6 Medium
	Increased habitat disturbance of megafauna species with increased turbidity and sedimentation of habitats due to prop wash.	(2, 4) 8 Medium	Provide designated shipping channels and Go Slow (6 knots) Zones to decrease and localise probability of habitat disturbance. Channel depths to be maintained. Consider extension of 6 knot speed restriction of Ross River to outer breakwater.	(1, 4) 4 Medium

3.10.7.6 Cumulative impacts and mitigation strategies – marine megafauna

The TMPP involves the construction of an industrial marine precinct at the mouth of the Ross River. Consequently the marine habitats in this area will be markedly disturbed. The main potential construction impacts include removal of benthic habitat, declines in water quality associated with construction events and potential impacts to marine megafauna from vessel operations. The main potential operational impacts include continuous disturbance of benthic marine systems, impacts to water quality, impacts to marine megafauna from vessel operations and increased potential of light pollution and pollution to the marine environment from changed use. Mitigation strategies against each impact were identified in the preceding section.

As the migratory marine fauna species discussed in this report utilise ecological scales for foraging and breeding of 100s of kilometres, it is pertinent to consider the impacts of the Precinct relative to a regional scale beyond Cleveland Bay, Townsville.

Within the Townsville region a number of other construction projects are occurring that have the potential to result in compounding or cumulative impacts. These other projects include the development of:

- The TPAR road and rail link, including a bridge across Ross River adjacent to the Precinct site;
- Development of Berth 12 to the north of the Precinct site in the outer harbour area of the port;
- Expansion of berths within the inner harbour of the port; and
- The Townsville Ocean Terminal (TOT) to the west of the port.

Beyond the Townsville region, port, sewage and other coastal infrastructure development plans are underway and likely to be developed and the environmental impacts assessed in isolation from Townsville developments.

Each of these projects is likely to include adverse effects on the marine environment including removal of benthic habitat, dredging operations and construction operations that may impact upon water quality and vessel movements that may affect marine fauna utilisation of the area.

The benthic environment that will be directly affected by construction of the Precinct is known to occur in other locations within Townsville region including in other locations within the Port, Rowes Bay, Pallarenda and Magnetic Island. The area to be effected by the Precinct is not considered to be a critical feeding ground for marine megafauna species. Quality seagrass habitats, dredged channels, rocky reef and estuarine interfaces have been identified as important habitat areas for key marine fauna species which are well represented beyond the Precinct.

Construction activities associated with the TPAR, Berth expansions and TOT will also all likely impact negatively upon the benthos occupying areas of the seabed in the direct vicinity of each development. The cumulative occurrence of this habitat removal and disturbance in conjunction with the development of the Precinct is not expected to negatively affect prevalence of marine megafauna fauna detected during this survey in the Townsville region given this benthic habitat is well represented in the area. Depending on the timing and extent of all the construction and development proposed for the region, marine megafauna species may be temporally or

permanently displaced if projects are timed to incur multiple construction impacts at once. The construction of the TMPP in isolation is not likely to impact marine megafauna species. Construction management plans should include consideration of cumulative impact potential and appropriate mitigation measures.

Various conservation threats including vulnerability to low levels of mortality and habitat degradation and loss (described in detail in Appendix U) have likely depleted the Cleveland Bay marine megafauna populations and hindered recovery to abundance levels estimated for the middle of the 20th century. This is despite significant interventions to protect these species against further human impacts. Potential impacts of further development and increases in vessel activity in the area need to be considered in relation to the potential cumulative effects of all threats described above with the ultimate aim of reducing the overall effects of human activities on marine megafauna populations. Although the species in this report are considered migratory and capable of avoiding some impacts, their inherent ecology coupled with numerous anthropogenic impacts renders them particularly vulnerable.

Megafauna other than stingrays (observed in the baseline marine ecology survey described in Section 3.10.6), including turtles, dugong or dolphins, were not noted to use Lot 773 or the immediate tidal waters. This is supported by a lack of key foraging habitat within the area, including, but not limited to, seagrasses. Seagrasses were, however, found offshore from the mouth of the Ross River (Rasheed and Taylor 2008). There is potential for degraded water quality to impact these offshore meadows particularly if dredging activities for the TPAR, Berth 12 and Precinct coincide and produce a larger or more persistent plume than anticipated by any single activity. Potential water quality impacts are discussed in detail under Section 3.9 of this report.

Seagrass communities, which are particularly important for marine megafauna, are also recognised to be important ecosystems for maintenance of seabed stability, water quality and biodiversity (Collier and Waycott, 2009). Rasheed and Taylor (2008) note that seagrasses in the vicinity of the Townsville port are likely adapted to high levels of turbidity both as a result of naturally occurring high turbidity for the area and also in response to existing levels of maintenance dredging and shipping activities. These compounding influences on turbidity are, however, recognised to be short-lived to which the meadows have resilience. Rasheed and Taylor (2008) and Collier and Waycott (2009) both note considerable risk of impact to seagrass meadow prevalence in the Townsville region from prolonged periods of reduced water quality resulting from confounding influences. This again highlights the need to consider timing of multiple project impacts.

Given the ecological importance of seagrasses within this region to megafauna, and the considerable risk of cumulative impacts to seagrass meadows from concurrent project development, consideration should be given to monitoring the presence and prevalence of seagrass meadows and the quality of associated water bodies adjacent to the port to determine if any negative influences from construction and operational activities affect these sensitive ecosystem receptors. Management response plans to declines in water quality and / or prevalence of seagrass meadows linked to development of the Marine Precinct should be developed. These may include, for instance, cessation of dredging activities or use of silt curtains to enable water quality levels to return to background conditions if unacceptable declines in water quality are detected during dredging activities.

Additional cumulative impacts that may result from a temporary increase in slow-moving vessel traffic associated with construction activities in the mouth of Ross River (TPAR and Precinct) include increasing potential for deleterious interactions with megafauna (turtles being impacted whilst resting on the substrate) or displacement of megafauna from the area. Development of a construction vessel management plan taking into consideration cumulative impact potentials and addressing management strategies including speed limitation, the presence of marine fauna spotters on vessels, appropriate strategies to avoid interaction with megafauna and reporting of any interactions should be considered.

Expected construction activity impacts identified above are likely possibilities under any of the other proposed adjacent projects. As a consequence, concurrent occurrence in adjacent sites and, therefore, confounding, of each of the identified impacts are also possible. Consistency in application of mitigation measures identified above should be considered for all other projects to reduce potential for cumulative impacts. In particular project specific development and adoption of proposed management plans for dredging, construction, waste management and hazardous material risks should be undertaken such that potential for cumulative, flow on effects, from other adjacent developments are considered and accounted for.

The project, under identified mitigation strategies, is not expected to have any significant or long term negative impacts upon the marine megafauna supported within the Cleveland Bay region.

3.10.7.7 Conclusion – marine megafauna

Literature on previous studies within the region was reviewed prior to conducting field work to provide information on seasonal habitat distribution and species presence to assist in designing the survey to meet local conditions and anticipated marine fauna. A survey program over seven months was implemented and included aerial and boat-based surveys for marine megafauna at a regional and finer spatial scale. Habitat utilisation of these areas by key marine fauna species (marine turtles, dugong and dolphins) was recorded and interpreted in the context of the proposed development.

The surveys did not detect any marine megafauna within the footprint of the development though they were found to occur within approximately 2 km of this area. Megafauna species identified on boat-based and aerial surveys include:

- Marine turtles (majority of observations were green turtle, *Chelonia mydas*) *N* = 27;
- Dugong (*Dugong dugon*) *N* = 32;
- Indo-Pacific humpback dolphins (*Sousa chinensis*) *N* = 6;
- Australian snubfin dolphin (*Orcaella heinsohni*) *N* = 2 (adult and calf);
- Bottlenose dolphins (*Tursiops* spp.) *N* = 2;
- Sharks, rays and a seasnake; and
- Unknown dolphin species *N* = 1.

N= maximum recorded individuals of a species in one sampling effort (aerial or boat-based)

The marine megafauna study supported a number of key findings:

- Marine megafauna species are widely distributed throughout Cleveland Bay;

- The Townsville Port environment and adjacent waters represent important habitat for Indo-Pacific humpback and Australian snubfin dolphins of various age classes. Previous research in the area indicates waters close to the Port of Townsville and Ross River mouth, including areas immediately surrounding the TMPP site; represent the most important habitat for snubfin and Indo-Pacific humpback dolphins within Cleveland Bay,
- Nesting and preferential feeding habitats for marine turtles do not occur within the immediate vicinity of the Project;
- Good quality foraging habitats exist for green turtles throughout much of Cleveland Bay and low density nesting by green and flatback turtles occurs on beaches within close proximity to the PoT (The Strand, Pallarenda and Magnetic Island) though not on the eastern side of Cleveland Bay;
- Critical nesting populations for these species exist in regions several hundred kilometres north and south of the Project Area;
- Dugong distribution recorded during the survey supports previous aerial survey observations by Marsh *et al.* (2005) and a close association with seagrass habitats.

The TMPP involves the construction of an industrial marine precinct at the mouth of the Ross River. Consequently the marine environment at this local scale will be markedly disturbed. In conjunction, within the Townsville region a number of other construction projects are occurring that have the potential to result in confounding or cumulative impacts. These other projects include the development of:

- The Townsville Port Access Corridor road and rail link, including a bridge across Ross River adjacent to the Precinct site;
- Development of Berth 12 to the north of the Precinct site in the outer harbour area of the port;
- Expansion of berths within the inner harbour of the port; and
- The Townsville Ocean Terminal (TOT) to the west of the port.

Each of these adjacent projects is likely to include adverse effects on the marine environment including removal of benthic seabed habitat, dredging operations and construction operations. In conjunction with the Marine Precinct development there is potential for greater, cumulative, impact upon water quality and vessel movements that may effect marine fauna utilisation of the area.

The main potential construction impacts, including potential cumulative impacts, that may result from the Precinct development include:

- Removal of benthic habitat,
- Degraded water quality associated with construction events; and
- Potential impacts to fauna, particularly marine megafauna, from vessel operations.

The main potential operational impacts from the Precinct development include:

- Continuous disturbance of benthic marine systems;
- Impacts to water quality;

- Impacts to marine megafauna from vessel operations; and
- Increased potential of pollution to the marine environment from changed use.

Proposed mitigation strategies against each impact were identified. In brief, these include:

- Implementation and use of designated shipping channels and consideration of go slow zones to avoid impacting upon benthic habitats and mobile species, including megafauna;
- Use of appropriate facility design to minimise ongoing pollution potential, including from light spill and slipways;
- Implementation of waste management plans and provision of waste facilities;
- Implementation of hazardous material handling requirements and provision of access to appropriate emergency response kits;
- Development and implementation of a dredge management plant to mitigate impacts on water quality;
- Consideration of provision of public education material to mitigate potential pollution and disturbance impacts; and
- A construction and operational phase Environmental Management Plan (EMP) is recommended to address the potential impacts from this Project that explicitly addresses the aforementioned issues, e.g. water quality. This implemented with the knowledge of other regional Project impacts and communication with regulatory agencies will best address potential impacts to marine megafauna.

3.10.8 Unmitigated ecological impacts and potential offsets

A number of impacts identified above have either partial or no mitigation measures to counteract them. These impacts are related to the disturbance of marine resources and, accordingly, trigger the need for assessment under the Fish Habitat Management Operational Policy FHMOPOO5 — *Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss, 2005*, administered by the DEEDI (as described under Section 1.9). The predicted impacts from the TMPP that are not able to be mitigated against, a description of the impacts and partial mitigation/offsets to each impact are identified in Table 3-55 and Table 3-58.

An ecosystems services assessment conducted for this EIS (refer Section 5.2) estimates the value of the ecosystem services to be lost from the development of the TMPP to be $757,960. This did not, however, take into consideration creation of new habitat through the partial mitigation measures.

The information provided here in Table 3-59 notes that although there are net losses of benthic substrate resulting from the TMPP there are a number of environmental gains that also result from the development and operation of the Precinct. This information is provided to facilitate discussion by DEEDI to determine whether any additional offsets are required beyond those currently achieved by the TMPP and POTL to compensate for the net loss of seabed habitat.

Table 3-59 Potential impacts relating to offsets under consideration for the TMPP

Habitat	Area	Ecological Value	Predicted Impact	Relevant Section of EIS
Terrestrial vegetation	-1.5 ha	Mangroves fragmented with weed species. Thin strip of vegetation between existing beach and port access road. Considered low value habitat.	Loss due to construction of TMPP and services corridor.	3.10.4
Benthic substrate - soft	-32.5 ha	Intertidal and subtidal benthic seabed. Muddy/sandy environment. Supports mainly molluscs, crustaceans and worms. Moderate ecological value. No marine plants. Not considered critical habitat for wading and migratory birds or marine megafauna.	Loss due to construction on Lot 773.	3.10.5, 3.10.6 and 3.10.7
Benthic substrate - soft	-2 ha	Subtidal benthic seabed. Muddy/sandy environment. Supports sparsely distributed taxa, mainly molluscs and worms. Low-moderate ecological value. No marine plants. Not considered critical habitat for wading and migratory birds or marine megafauna.	Loss due to construction of breakwater.	3.10.5, 3.10.6 and 3.10.7
Benthic substrate – soft Inner harbour	+7.1 ha	Subtidal benthic seabed. Muddy/sandy environment. Expected to supports molluscs, crustaceans and worms. Expected to have moderate ecological value. Not expected to support marine plants. Not expected to be critical habitat for wading and migratory birds or marine megafauna.	Gain of subtidal benthic soft sediment due to creation of inner harbour of TMPP. Replacing some habitat lost during construction on Lot 773. Note does not include area of channel, as this effectively doesn't change habitat type from construction.	2 and 3.10.5

Habitat	Area	Ecological Value	Predicted Impact	Relevant Section of EIS
Benthic substrate – hard Precinct	+1.8 ha	Rocky subtidal habitat. Will support hard substrate taxa including crustaceans. May provide habitat that different taxa can colonise, such as sponges.	Subtidal habitat gain due to creation of Precinct rock revetment and quayline. Expected to act as niche refuge for fishes and crustaceans.	2 and 3.10.5
Benthic substrate – hard Precinct	+1.5	Rocky intertidal habitat. Will support hard substrate intertidal taxa including crustaceans, barnacles and molluscs.	Intertidal habitat gain due to creation of Precinct rock revetment and quayline. Expected to support intertidal taxa including crustaceans.	
Benthic substrate – hard Breakwater	+0.6 ha	Rocky subtidal habitat. Will support hard substrate taxa including crustaceans. May provide habitat that different taxa can colonise, such as sponges.	Subtidal habitat gain due to creation of offshore breakwater. Expected to act as niche refuge for fishes and crustaceans.	2 and 3.10.5
Benthic substrate – hard Breakwater	+0.8 ha	Rocky intertidal habitat. Will support hard substrate intertidal taxa including crustaceans, barnacles and molluscs.	Intertidal habitat gain due to creation of offshore breakwater. This and all above tidal habitat may act as an alternative roost or refuge for marine birds.	2 and 3.10.5
Saltpan – upstream of TMPP	+32 ha	Moderate ecological value. Rehabilitated post utilisation of area as a prawn farm. Expected to be recolonised by saltmarsh vegetation.	Habitat gain from rehabilitation of previously occupied commercial site.	Undertaken by POTL within last 12 months independently of the TMPP. Claimed as a credit.

Habitat	Area	Ecological Value	Predicted Impact	Relevant Section of EIS
Water quality	TMPP project area	High ecological value as good water quality intrinsically important for support of healthy marine ecosystems. Currently some levels of contaminants in areas adjacent to Precinct footprint.	Opportunity to co-locate commercial industries into a new, purpose built, facility. Potential for improving the water quality in the lower reach of Ross River.	3.9

3.11 Air quality

3.11.1 Description of environmental values

The DERM has a monitoring network of five sites in Townsville. Results from this monitoring, along with additional industry monitoring from the Townsville Port Authority and Sun Metals Corporation, are reported on monthly[6] and annually[7] by the DERM.

The gaseous pollutants of Ozone (O_3), Nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2) are measured by the DERM at Pimlico (inland and to the South-east of the Port) while industrial monitoring of SO_2 is done by Sun Metals at Stuart (well inland and south of the Port). Respirable particulate matter (PM10) is measured at Pimlico (DERM) and the Townsville Port (industry). The DERM have a more extensive network for Dustfall and Total Suspended Particulate matter (TSP) at the Coast Guard, South Townsville, North Ward and Yarrawonga to supplement dustfall measured at Pimlico. These dust measurements, from March 2008, speciate for various metals[8] (TSP) and Lead (TSP and dustfall).

The following information, from DERM annual reporting for 2007 against the National Environment Protection (Ambient Air Quality) Measure requirements[9], summarises the air quality environmental values for the Townsville airshed:

- Carbon monoxide (CO) is not required to be monitored because “pollutant levels are reasonably expected to be consistently below the relevant NEPM standard”;
- Monitoring at Pimlico “over the period 2004 to 2007 has shown nitrogen dioxide levels to be consistently below 40 percent of the NEPM standards”;
- Lead falls into the same category as CO (however monitoring has commenced in Townsville around industrial sources from May 2008);
- Of the five regions reporting against the 24-hour PM10 NEPM standard (South-east Queensland, Toowoomba, Gladstone and Mackay), Townsville was the lowest;

6 http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_quality_reports/monthly_bulletins/

7 http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_quality_reports/

8 TSP measured one day in six and analysed metals are Copper, Zinc, Nickel, Arsenic, and Cadmium as well as Lead

9 http://www.epa.qld.gov.au/publications/p02572aa.pdf/Queensland_2007_air_monitoring_report.pdf