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Shute Harbour Marina Development P/L

Final Report

Marine Megafauna Impact Assessment and Management Plan

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EXECUTIVE SUMMARY

Shute Harbour Marina Development Pty Ltd (SHMD) proposes to construct an integrated marina, resort hotel, commercial and managed resort accommodation precinct at Shute Harbour, in Whitsunday Shire.

As part of the development planning process the proposal was referred to the Commonwealth Department of Environment and Heritage (DEH, now Department of the Environment, Water, Heritage and the Arts) because of its potential impact on matters of National Environmental Significance (world heritage, listed threatened species and communities, listed migratory species and marine environment) under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). DEH's Decision Notice recognised the importance and potential impact of the proposed development on these matters and the project was declared a "controlled action" and subject to the controlling provisions under the EPBC Act.

The project has also been declared a "significant project" under the Queensland *State Development and Public Works Organisation Act* 1971 (SDPWO Act), for which an Environmental Impact Statement (EIS) is required. The Terms of Reference (ToR) for this EIS included a requirement for SHMD to describe any rare or threatened marine species, particularly dugong and marine turtles and describe potential impacts to these species and mitigation measures to be applied. The EIS process under the SDPWO Act has been accredited by DEH for the purpose of environmental assessment under the EPBC Act.

This Marine Megafauna Management Plan (MMMP) aims to address the needs of the ToR in relation to assessing potential impacts on marine megafauna species, particularly dugong, turtle, whale and dolphin species. It discusses the ecology of species likely to occur in Shute Bay and wider Whitsunday region, potential impacts to these species and associated mitigation strategies, in addition to outlining management requirements aimed at ensuring the proposed development has minimal impact upon them.

The MMMP was developed through a process of desktop review of available information; assessment of potential impacts and prioritisation of impacts through a risk assessment process; and identification of mitigation strategies to minimise the likelihood and/or consequences of significant and moderate risk impacts. The process and outcomes of this approach were subject to a workshop of experts and regulatory agency representatives in December 2006 and served to ensure that the study was comprehensive, rigorous and addressed their needs and expectations.

The project has the potential to impact on a range of marine turtle and mammal species, which are protected under State and Commonwealth legislation. Marine megafauna species that have either been recorded in Shute Bay, or may be reasonably expected to occur there because suitable habitat or food sources exist, include: dugongs, flatback turtles, green turtles, loggerhead turtles, and hawksbill turtles. While Shute Bay may present suitable habitat or food sources to these species, the bay is not considered to be of critical or high importance since usage of the area appears to be relatively low, possibly due to relatively sparse resources when compared to other areas within the Whitsunday region. Of particular importance is the understanding that no turtle nesting beaches occur in or near Shute Bay and no major breeding sites occur within the Whitsunday area.

Other significant species would occur in the Whitsunday region but would not occur within the bay. For example, the Humpback whale does not occur within Shute Bay, but is known to frequent the Whitsunday islands and passage, which are important resting and breeding grounds for this species. Inshore dolphin species, Australian snubfin dolphin and Indo-Pacific humpback dolphin, are not expected to occur in Shute Bay as the bay is outside the dolphins' range from the

nearest significant estuaries where they might occur. Leatherback turtles would also not occur within Shute Bay as they prefer pelagic habitats; however they might occur in the Whitsunday region.

The risk assessment determined that there were no potential impacts from the construction or operation of the Shute Harbour Marina Development that represented an "intolerable risk" which cannot be justified. Several "significant risks" were identified relating to: boating disturbance and boat strike, local habitat/food source loss, oil spills, marine debris and minor incidental sewage discharge. Effective measures can be actioned at a senior management level to reduce these risks. These include measures through the design, construction and operational phases of the project. Experts expressed that boating disturbance and boat strike were the most critical of these risks, and will require responses at the local and regional level with a particular focus on regularly educating boat users about best management practice.

"Moderate risk" potential impacts relevant to marine megafauna include: coastal development cumulative effects, construction in the marine environment, dredging impacts on water quality, loss of invertebrate and seagrass as food sources in Shute Bay, artificial lighting, and water quality degradation. These impact risks can be managed through the implementation of cost effective measures and formalize routine measures.

1.0 INTRODUCTION

1.1 BACKGROUND

Natural Solutions Pty Ltd was engaged by Shute Harbour Marina Development Pty Ltd (SHMD) to prepare a Marine Megafauna Impact Assessment and Management Plan for the proposed Shute Harbour Marina Development at Shute Bay, Shute Harbour.

SHMD proposes to construct an integrated marina, resort hotel, commercial and managed resort accommodation precinct at Shute Harbour.

SHMD undertook an Environmental Impact Statement (EIS) for an initial design concept in 2005 (refer to Figure 1.1:) and substantial feedback was provided to the proponents with regard to the proposed design elements. It became apparent from the EIS feedback that significant components of the project needed to be reviewed. Included in the feedback was a need to undertake a more detailed assessment of the potential impacts to marine megafauna, particularly in relation to dugong, dolphins and marine turtles.

The initial marina development concept design has been revised by SHMD, which is charged with delivering and operating a sustainable marina development, and significant changes have now been incorporated into the current master plan design concept. In summary the changes include:

- Removal of the Transit Terminal and Ship Repair Facility from the project;
- A significant reduction in land based development with only a 5,000 square metre increase in reclamation;
- No development of the land areas abutting Conway National Park;
- The inclusion of a public esplanade along the entire frontage of the development;
- Contribution to construction of public boat ramp facilities; and
- An increased development footprint in terms of additional marina berths.

Figure 1.1: 2005 Shute Harbour Marina Masterplan

1.2 PROPOSED DEVELOPMENT

The concept master plan for the revised concept for the proposed Shute Harbour Marina Development incorporates water and land based components, which are introduced below and are shown in the Master Plan drawing (Figure 1.2:).

Marina

The proposed marina includes the following design features:

- A marina providing 669 berths (including 193 multi hull berths);
- Excavation and dredging of the marina basin to achieve navigation depths to suit the types and sizes of vessels to be accommodated;
- A breakwater located at the eastern and southern edges of the site to control and dampen wave action and induce calm conditions within the marina basin;
- Floating pontoons supported by driven piles for marina berths accommodating vessels of various sizes ranging from 11 m to 35 m in length and including berths for large catamarans;
- A base for charter boats;
- Sullage pump-out facility;
- Fuelling berth; and
- All required navigation aids, lights and signage.

Onshore Development

Some sand and fill materials will be imported from terrestrial areas which, when combined with excavated material from the marina basin, will form the platform for the onshore development. The water edge will be retained with revetment walls. The onshore development will be set at levels to accommodate the tidal range and predicted increases in sea levels due to storm conditions and greenhouse effects.

A summary of the commercial and residential precincts and proposed infrastructure services is provided below.

Commercial and Tourism Precinct

The proposed commercial and tourism precinct includes the following design features:

- A four star tourist resort up to five storeys comprising 109 family suites with underground car parking;
- Marina Office, amenities and car parking;
- Charter boat base comprising a range of charter boat tenancies, administration and amenities; and
- Retail and restaurants.

Managed Resort Accommodation Precinct: Foreshore

The proposed residential precinct includes the following design features:

- High quality residential environment comprising 117 lots; and
- Allotments will accommodate up to three storey dwellings.

Infrastructure Services

The following infrastructure services are included in the design:

- A full range of site services such as power, water, sewer, stormwater drainage and telecommunications will be provided; and
- A new intersection at the entrance on Shute Harbour Road.

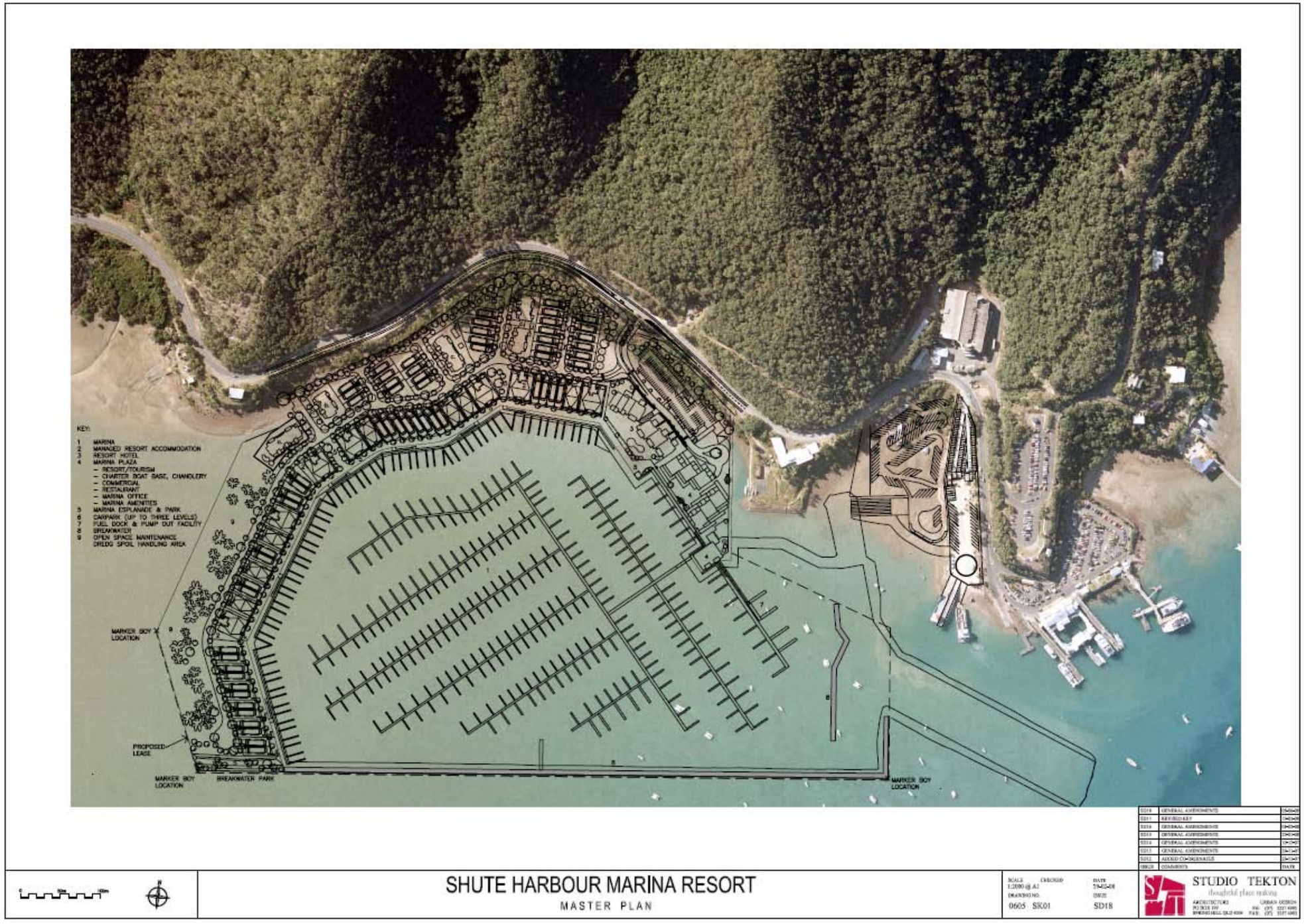

Figure 1.2: Shute Harbour Marina Current Master Plan

1.2.1 Construction Processes

Five phases will be required to construct the Shute Harbour Marina Development. These are summarised below but are explained in more detail in the EIS.

Phase 1: Preliminary site works and earthworks
Phase 2: Construction of Area 1 (eastern portion of marina)
Phase 3: Constructing of Area 2 (western portion of marina), revetment wall and breakwater
Phase 4: Dredging of remainder of marina basin and entrance channel
Phase 5: a) Roadworks, services, infrastructure and marina fitout; b) upgrading of Shute Harbour Road.

The construction process phasing has been designed to include a range of temporary works to enclose Areas 1 and 2 within the marina during Phases 2 and 3 to enable a majority of the earthworks to be completed in the dry using conventional excavation and placement methods. These temporary works include construction of a sheet pile wall and earth bund to protect work from tidal inundation.

The solid breakwater structure to be installed in Phase 3 will be constructed using steel pile structure to support pre-cast concrete units. The steel piles will be driven using a conventional hammer pile driving rig mounted on a barge.

The wet excavation of the remainder of the marina basin in Phase 4 will be undertaken using a cutter suction dredge. The dredging of the basin will not commence until the marina is enclosed by the revetment wall, breakwater, temporary sheet piling and silt curtain. This approach will limit dredge plume development, but modelling by Cardno Lawson Treloar (2007; refer to EIS for further information regarding dredge plume modelling) identifies some plume generation in the entrance channel Shute Harbour Ferry terminal area.

The fitout of the marina with floating pontoons and catwalks will be undertaken during the last phase of development. The floating marina will require piling and the supply and installation of pontoons and associated catwalks, power, potable and fire water services. Installation of the piles will be from a barge mounted piling rig.

1.2.2 Operational Processes

1.2.2.1 Estimated Frequency of Maintenance Dredging

The basin will be over dredged during construction to minimise the requirement for maintenance dredging during the first ten years. With an initial over dredging of over 0.2 m, it is likely that maintenance dredging would not occur until after 10 years of operation, unless it is necessary after a severe cyclone event or when monitoring indicates that it is required.

After initial dredging, the maintenance dredging rate should stabilise to approximately 3000 m3 per year due to the:

- Stabilisation of dredge batter slopes;
- Stabilisation of the sea bed below the breakwaters; and
- Decrease of fine sediments available within the bay.

The marina is being designed so that maintenance dredging is required only every 5 to 7 years.

A very detailed analysis of coastal processes and resulting issues associated with maintenance dredging are shown in a report by Cardno Lawson Treloar in Appendix O of the EIS.

1.2.2.2 Disposal of Maintenance Dredging Material

A maintenance dredge spoil handling area is located at the western sector of the site adjacent to the access road to waterfront managed resort accommodation allotments and is denoted as Area 9 in the master plan Figure 1.1. The area comprises approximately 19,000 m2. The disposal area is retained on, Figure 1.2. Prior to maintenance dredging commencing, the required part of the maintenance dredge spoil handling area will area will have the vegetation and turf removed. Geobags will be placed on this area and the dredge spoil pumped into the bags. The Geobags will provide primary filtration, with the several hundred metres of the sand filled handling area providing final filtration prior to the water being collected by pipes, located above an impermeable layer separating the sand from the lower substrate, and reintroduced to the bay.

The dewatering of the dredge spoil by the use of Geobags is much quicker than would be achieved by traditional settling ponds. Being assisted by gravity and by loading through stacking the bags vertically, dredge spoil can be dewatered in days and weeks rather than years. The material in the Geobags will then be removed by trucks for land based disposal.

After completion of the maintenance dredging operation and transport of the spoil, the area will be reinstated with turf and vegetation to return the area to its former use as open space.

1.3 SUBJECT SITE

The site is located in Shute Bay (refer Figure 1.3) within the Whitsunday Shire Council local government area. The site is located at Shute Harbour Road, Shute Harbour and is described as Lot 2 on Plan SP 117389, Lot 273 on Plan HR1757 and portion of Shute Harbour Road abutting the north-west corner of Lot 2 north of Shute Harbour Road. The site is located outside the Commonwealth Great Barrier Reef Marine Park (GBRMP), and within State Great Barrier Reef Coast Marine Park (GBRCMP) and partly within the Great Barrier Reef World Heritage area (GBRWHA). The site has a marine park zoning of 'Habitat Protection'. This zoning allows for the development of a marina facility, with appropriate approvals. The project site is listed on the Directory of Important Wetlands, however lies outside of any Dugong Protection Areas or Fish Habitat Areas (FHA). The site abuts Conway National Park on the northern boundary, however the proposal is not to develop any land north of Shute Harbour road and return the land abutting the national park to public ownership.

Figure 1.3: Location of Shute Bay along Queensland Coast

1.4 PURPOSE AND OBJECTIVES OF THIS PLAN

1.4.1 Purpose of this Plan

This plan aims to:

- Identify priority risks to marine megafauna likely to result from the development and operation of the Shute Harbour Marina Development; and
- Propose effective mitigation strategies to minimise impacts.

This is undertaken to satisfy the following drivers:

- SHMD's objective of providing long term sustainable benefits from the Shute Harbour Marina;

- Requirements under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act); and
- Requirements of the Terms of Reference for the Shute Harbour Marina Development issued under the *State Development and Public Works Organisation Act* 1971 (SDPWO Act).

1.4.2 Objectives of this Plan

The primary objectives of this Marine Megafauna Management Plan are to:

- Provide background information on megafauna ecology likely to occur in the Shute Harbour area;
- Highlight conservation threats to these species;
- Provide available baseline data for the subject site and surrounds;
- Undertake a risk assessment of potential impacts;
- Discuss priority impacts of the proposed development on marine megafauna species likely to occur in the area;
- Undertake a workshop of Queensland turtle and dugong experts to review impact risks and prioritise mitigation/management measures to avoid/minimise negative impacts; and
- Provide a management and monitoring program to guide implementation of this Marine Megafauna Management Plan.

In order to gain a perspective of the marine values and the relative importance of these in a regional context, information has been provided for marine values within Shute Bay and the general Whitsunday region.

1.5 REPORT FORMAT

This marine megafauna management plan comprises 11 sections. Table 1.1 gives a brief description of the content of each section.

TABLE 1.1 OVERVIEW OF EACH SECTION OF THIS REPORT

REPORT SECTION	SECTION TITLE	DESCRIPTION
1.0	Introduction	Introduction to the project, the subject site and objectives of this report.
2.0	Summary of Marine Habitats of the Project Site and Surrounds	Brief summary of the marine habitat within the project site and surrounding bay.
3.0	Legislative Framework	Outlines the Commonwealth and State legislation relevant to the project in relation to marine megafauna.
0	EPBC Listed Marine Mega Fauna	Identifies EPBC listed marine megafauna that have been recorded in the Whitsunday Region.
5.0	Marine Megafauna Species	Profiles marine megafauna species that are considered to have

REPORT SECTION	SECTION TITLE	DESCRIPTION
	Profiles	the potential to utilise the project site and surrounding inshore waters of the Whitsundays. Profiles give a physical description of the species and outline the distribution, population, habitat, diet, breeding, threats, conservation status and the significance of the project site to the species.
6.0	Survival Pressures	Outlines the survival pressures, both natural and anthropogenic, that marine megafauna face. Also details recorded marine megafauna deaths from the Whitsunday area.
7.0	Potential Anthropogenic Impacts	Lists anthropogenic impacts on marine megafauna populations which are to be used as a basis for the project megafauna risk assessment.
8.0	Risk Assessment Process	Details the risk assessment process utilised for the project and gives the results of the project megafauna risk assessment.
9.0	Priority Impacts and Mitigation Strategies	Gives further details on risks that were identified as 'significant' and 'moderate', in particular how they impact marine megafauna and presents mitigation strategies to be implemented.
10.0	Conclusions and Management Recommendations	Conclusions regarding the potential impacts that the proposed development may have on marine megafauna based on the review of literature and risk assessment detailed in the previous sections of the report. Also includes management recommendations for the design, construction and operation phases of the project.
11.0	References	References.

2.0 SUMMARY OF MARINE HABITATS OF THE PROJECT SITE AND SURROUNDS

This section summarises the marine habitats in the vicinity of the project site and provides a regional context. More detailed information regarding seagrass, reef, mangroves and saltmarsh is available separately in a marine ecology report by FRC Environmental (2008). Information below is extracted from the FRC Environmental report unless stated otherwise.

2.1 GENERAL CHARACTERISTICS OF SHUTE BAY

Much of Shute Bay is intertidal, and sediments grade from coarse sand and rocks in the shallow subtidal areas, to fine silt in the centre of the development footprint. Mangrove communities dominated by Rhizophora sp. fringe the shoreline, supporting a benthic fauna dominated by crabs and gastropods. Patches of saltmarsh occur on the mostly rocky ground and extend landward. Beyond this intertidal zone, the land rises over a relatively steep slope to Shute Harbour Road.

In the intertidal and shallow subtidal areas there are patchy seagrass and macroalgal communities, with a shallow coral community extending along a spit on the south eastern side of the bay.

2.2 SEAGRASSES

2.2.1 Within and Adjacent to the Marina Footprint

A survey of seagrass in April 2007 by FRC Environmental identified that seagrass is sparsely distributed within the marina footprint and adjacent areas of Shute Bay with the area generally consisting of bare substrate. Seagrass coverage is classified as being sparse (<5% cover), moderate (5-59% cover) or dense (59 – 100% cover). Traverses of the proposed development site, channel extension and adjacent areas, found very patchy, sparse cover of *Halophila ovalis* (Paddle Weed) and *Halodule uninervis* (no common name) encroaching on the marinas proposed southern breakwater area. On the western breakwater a moderately dense bed of *H. uninervis* was identified (refer Figure 2.1).

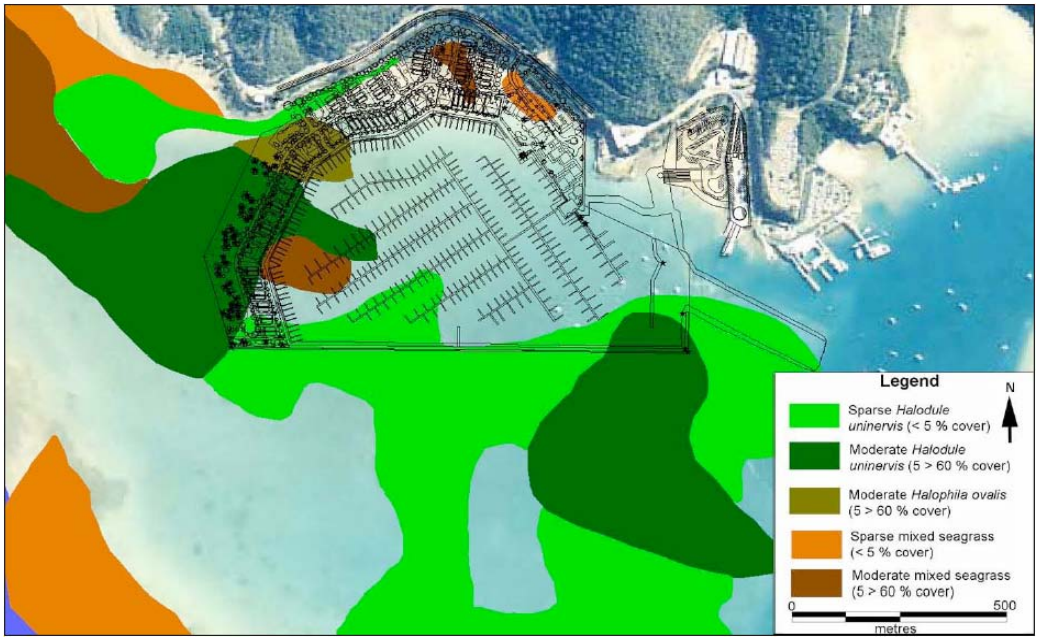

Figure 2.1 Seagrass communities within the development footprint in 2007. Source: FRC Environmental, 2008

The biomass of seagrass within and adjacent to the marina footprint is reported as relatively low for the species represented, and low for tropical seagrasses generally. The average above ground dry weight and the average below ground dry weight were both less than 1.0g DWm-2 for both Paddle Weed and *H. uninervis*. This is identified in Rasheed *et al* (2006) to equate to a light density of seagrass for these species, compared to a moderate density which would typically have a dry weight of between 1.1 and 4.9g DWm-2.

2.2.2 Within and Adjacent to the Access Channel Footprint

Seagrass has a patchy distribution within the proposed marina access channel. Communities are similar to those of the development footprint, composed of a mixture of Paddle Weed and *H. uninervis*.

Patches of seagrass in the area of the proposed access channel are very sparse. The percent cover of seagrass within individual patches is less than 5% (FRC Environmental, 2008).

2.2.3 In Shute Bay

A large portion of sediments in Shute Bay are covered with Seagrass totalling an area of approximately 147ha (refer Figure 2.2). The composition of seagrass communities is highly variable spatially and based on FRC Environmental's April 2007 survey, consists of a mixture of *H. uninervis*, *H. ovalis* and *Zostera muelleri*. *H. uninervis* dominated communities are found in the middle of the bay. *Z. muelleri* typically fringe the mangrove communities in the southern bay. No *Cymodocea serrulata* was identified during this survey. Mixed dense seagrass beds were recorded closer to the mouth and the southern side of the bay and covered the majority of the intertidal zone on the western side of the bay (FRC Environmental, 2008).

Seagrasses of the central bay are dominated by a morphology reflecting the relative harshness of conditions in this part of the embayment (i.e. short, narrow leaves). Seagrass from the southern side of the bay have larger longer leaves and more extensive rhizomes, suggesting that individual plants may be older and less disturbed in this area.

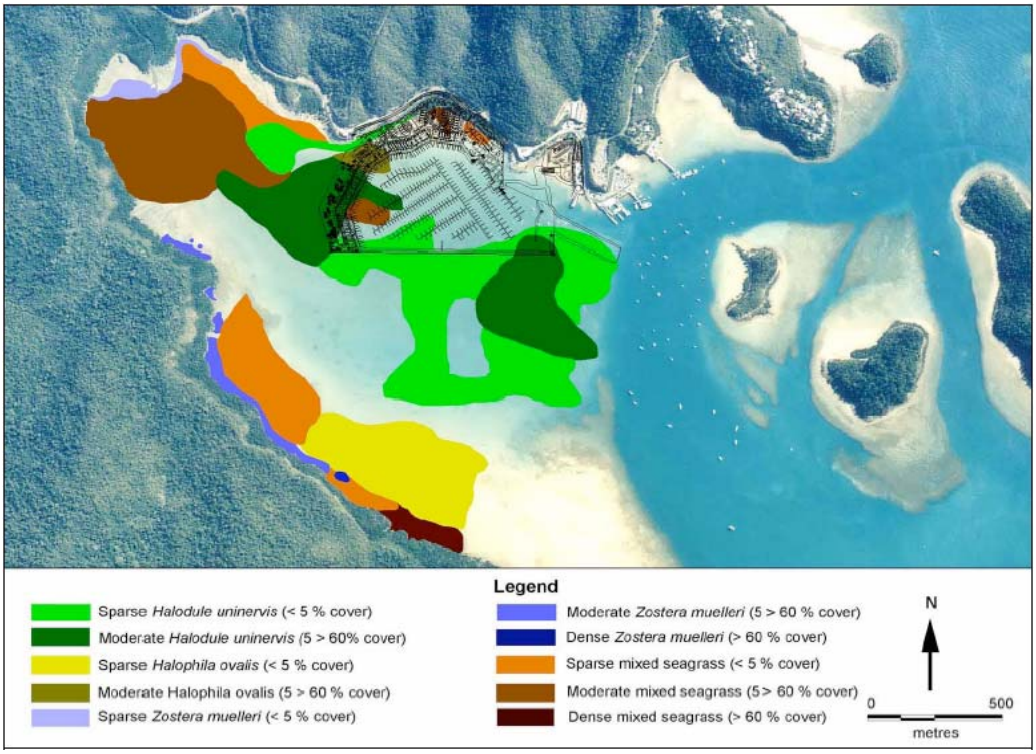

Figure 2.2 Seagrass distribution in Shute Bay in 2007. Source: FRC Environmental, 2008

2.2.4 A Regional Perspective

The seagrass species recorded from Shute Bay are common within the Whitsunday region, and more generally within shallow, sheltered, inshore environments of Australia's tropical east coast (Campbell *et. al*., 2002; Coles *et. al.* 1987; Coles *et. al.,* 2004; FRC Environmental 2002a; Lanyon 1986; cited in Connell Wagner 2005).

Within the coastal Whitsunday region, seagrasses are significantly denser in Charlie's Bay and Pioneer Bay about 10 to 15 km north of Shute Bay, refer to Table 2.1. Embayments closer to Shute Bay appear to have decreasing densities of seagrass. Boat Haven Bay has moderate seagrass density and Shute Haven and Shute Bay have sparse seagrass. These seagrass densities are reflected in apparent turtle usage of the bays, with turtles being most common in Charlie's Bay and Pioneer Bay (Pers. Comm. John Thorogood, FRC Environmental, 19 December 2006). The difference in seagrass distribution between the various bays is likely due to different turbidity levels, which are related to hydrodynamics and sedimentation characteristics.

TABLE 2.1 MEAN ABOVE-GROUND BIOMASS (G DW M-2) AND THE AERIAL EXTENT OF SEAGRASS FOR 14 LOCATIONS IN THE WHITSUNDAY REGION (CAMPBELL ET AL, 2002)

(Source: FRC Environmental, 2008)

LOCATION	MEAN ABOVE GROUND BIOMASS (G DW M^{-2})	AERIAL EXTENT (HA)
Hydeaway Bay / Dingo Bay	2.95	388.9
George Point to Earlando	3.11	243.9
Earlando to Woodwark Bay	0.53	233.6
Pioneer Bay to Funnel Bay	0.59	141.1
Shute Harbour	1.35	258.6

Trammel & Woodcutters Bays	4.03	122.4
Cow & Calf Islands to Cape Conway	2.86	271.5
Northern Repulse Bay	0.31	822.4
Southern Repulse Bay	0.14	692.3
Cid Harbour	7.25	340.2
North west coast of Whitsunday Island	14.77	1,432.7
Tongue Inlet	10.71	241.6
Whitehaven Beach	7.73	363.6
South Molle Island	0.01	4.0
Mean Biomass (all Locations)	5.5	
Total Aerial Extent		5,553

2.3 REEF COMMUNITIES

2.3.1 Within and Adjacent to the Marina Footprint

The intertidal zone within the footprint of the development supports approximately 10 coral communities, covering less than 2% of the substrate in this area (refer Figure 2.3). Corals in this area are small and appear healthy with no signs of stress. Colonies are represented by the families Faviidae and Mussidae (FRC Environmental, 2008).

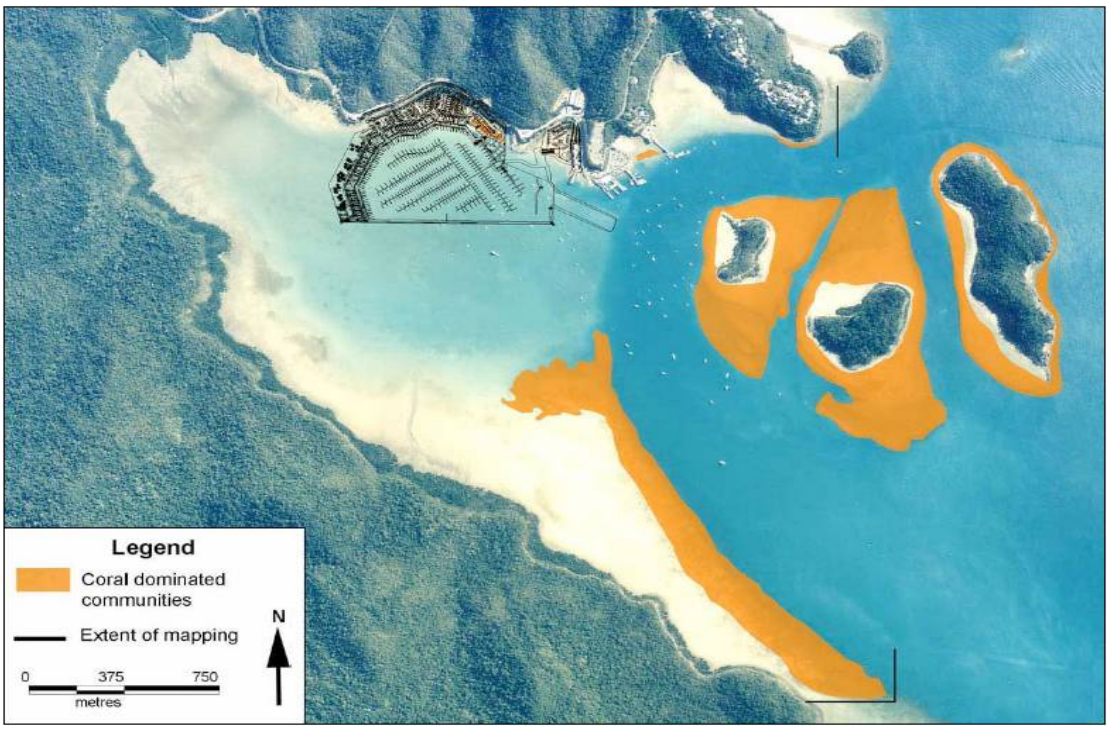

Figure 2.3 Coral communities of Shute Bay.
Source: FRC Environmental, 2008.

2.3.2 Within and Adjacent to the Access Channel Footprint

No coral is located within the proposed access channel extension (refer Figure 2.3).

2.3.3 In Shute Bay

A coral community forms an extensive spit that partially encloses the Bay's southern entrance. This community extends from an intertidal reef flat extensively covered by the brown alga *Padina* sp. (Funnel Weed), to a gradual reef slope that meets a sandy seabed at approximately 5.5 m below Lowest Astronomical Tide (LAT). Coral communities also fringe Repair, Tancred and Shute Islands at the entrance to Shute Bay (FRC Environmental, 2008).

Coral cover on the spit is highest on the seaward side, where tidal flushing is greatest, bringing food and clear water to the community. The point of the spit has an intermediate level of cover and the embayment side, which is less exposed, has lower coral cover and more fine silt covering bare substrate. Sparse patches of seagrass (*Halophila ovalis*) occur over the sandy bottom on the inshore side of the spit (FRC Environmental, 2008).

The relative abundance of each hard coral genus is typical of inshore coral communities in the Whitsunday region, with sediment tolerant genera such as *Goniopora*, *Porites* and *Turbinaria* dominating (FRC Environmental, 2008).

There are also hard and soft coral colonies on pylons and rock walls around the existing Shute Harbour Ferry Terminal. These isolated colonies are mostly *Pocillopora damicornis*, a hardy, pioneering species, and the sediment tolerant *Turbinaria* species.

As with seagrasses, the distribution of corals within Shute Bay is likely determined by turbidity levels, which are related to hydrodynamics and sedimentation characteristics.

2.3.4 A Regional Perspective

There is a discontinuous fringe of coral communities along the rocky shores of the Whitsunday coast, whilst the Whitsunday Islands support more extensive coral communities. The coral community found on the spit on the south western side of Shute Bay is relatively small in comparison. The cover and taxonomic composition of the hard and soft corals, other benthic fauna, and macroalgae found on the spit are typical of inshore coral communities in the region (FRC Environmental, 2008).

2.4 MANGROVE AND SALTMARSH COMMUNITIES

2.4.1 Within and Adjacent to the Marina Footprint

The shoreline within the footprint of the proposed marina, as with most of Shute Bay, is fringed by mangroves, of which there were approximately 1.84ha in April 2007. Within and east of the proposed marina, mangroves give way to the landward, to patches of saltmarsh on mostly rocky ground. To the west, the mangroves continue landward into a wider swampy area without saltmash (FRC Environmental, 2008).

Rhizophora stylosa dominates the seaward fringe of the mangrove community in the footprint of the proposed marina, forming a band approximately 15m wide and an open canopy approximately 4m high. *Avicennia marina* and *A. corniculatum* are intermixed throughout this community, becoming most abundant to the west where the substrate is coarsest. Further landward the community is dominated by *Ceriops* sp., intermixed with *Osbornia octodonata*, *Sonneratia alba*, *Excoecaria agallocha*. This landward mangrove community forms an open canopy that is approximately 2.5m high. Slightly landward of the *Ceriops*, and sometimes intermixed with them, are small patches of saltmarsh (mainly *Suaeda australis* and *Sporobolus virginicus*) on coarse rocky ground with almost no pooled water (FRC Environmental, 2008).

The mangrove community, within, and adjacent to, the marina footprint appears relatively healthy. However, due to the narrow fringe, mangroves in this area are of relatively low value to fisheries, when compared to the mangroves in the west and south of the bay. Towards the western end of the footprint of the proposed marina, where they are most exposed to the prevailing south-easterly winds and the substrate is coarsest, the mangroves are increasingly stunted (FRC Environmental, 2008).

2.4.2 Within and Adjacent to the Access Channel Footprint

2.4.3 In Shute Bay

Mangrove communities throughout Shute Bay are dominated by the red mangrove (*Rhizophora stylosa*), with lower abundances of the grey mangrove (*Avicennia marina*), river mangrove (*Aegiceras corniculatum*), myrtle mangrove (*Osbornia octodanta*), blind-your-eye mangrove (*Excoecaria agallocha*), mangrove apple (*Sonneratia alba*) and yellow mangrove (*Ceriops tegal*) also found throughout the bay. The black mangrove (*Lumnitzera* sp.) was scattered throughout the mangrove forest in the bight of the bay, while the mangrove fern (*Acrostichum speciosum*) and mangrove lily (*Crinum pedunculatum*) were recorded from the landward edge of the forest on the southern side of the bay.

The mangrove communities on the western and southern sides of Shute Bay cover a significantly greater area (being less constrained by higher land) than those within, or to the east of, the area of the proposed marina, refer to Figure 2.4 (FRC Environmental, 2008).

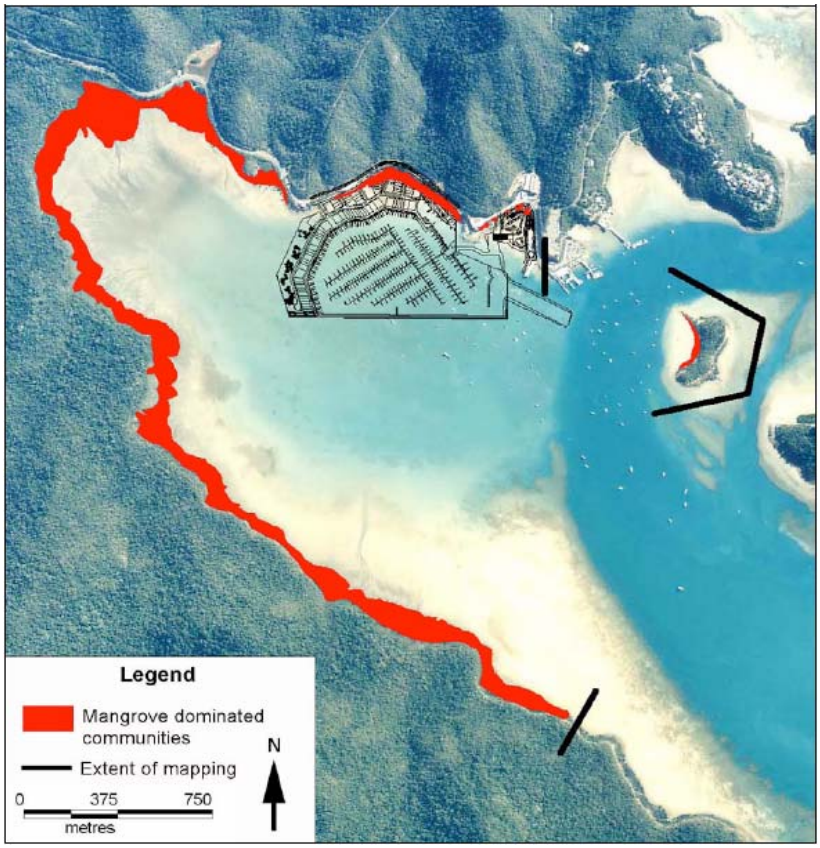

Figure 2.4 Mangrove communities of Shute Bay. Source: FRC Environmental, 2008.

2.4.4 A Regional Perspective

Compared to Repulse Bay to the south, and to a lesser extent, Pioneer Bay in the north, Shute Bay supports a relatively small area of mangroves. Each of the mangrove species recorded from Shute Bay is typical of, and common within the region (FRC Environmental, 2008).

3.0 LEGISLATIVE FRAMEWORK

As indicated in Section 1.4, the Shute Harbour Marina Development Project is subject to impact assessment under the Commonwealth (EPBC Act) and State (SDPWO Act) environmental legislation. This section briefly outlines the impact assessment requirements under these Acts.

3.1 GENERAL

3.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides that any action (i.e. a project, development, undertaking, activity or series of activities) which has, will have or is likely to have a significant impact on a matter of National Environmental Significance, or other matters protected under the Act, requires approval from the Commonwealth Environment Minister (the Minister). If the Minister decides that approval is required, the proposed action is termed a "controlled action". The proposal will then pass through a formal assessment and approval process before it can proceed.

The matters of National Environmental Significance identified in the EPBC Act as triggers for the Commonwealth assessment and approval regime are:

- National Heritage places;
- World Heritage properties;
- Ramsar wetlands of international importance;
- Listed migratory species;
- Listed threatened species and ecological communities;
- Commonwealth marine areas (and Commonwealth land); and
- Nuclear actions.

Shute Harbour Marina Development Pty Ltd has submitted an EPBC Referral Form for the marina development to the Commonwealth Department of Environment and Heritage (DEH) in December 2003 (for the initial concept) and in July 2006 (for the revised concept). The Minister declared the project to be a “controlled action” in Decision Notices issued on 24 December 2003 and on 27 July 2006.

Under both Decision Notices, the Part 3, Division 1, controlling provisions are:

- Sections 12 and 15A (World Heritage);
- Sections 18 and 18A (Listed threatened species and communities);
- Sections 20 and 20A (Listed migratory species); and
- Section 23 and 24A (Marine Environment).

The EIS process under the SDPWO Act has been accredited by DEH for the purpose of environmental assessment under the EPBC Act.

3.1.2 State Development and Public Works Organisation Act 1971

Under Section 26 of the SDPWO Act, the Coordinator General may declare a project to be a “significant project” for which an EIS is required. The EIS process for significant projects is described in Division 3, Part 4 of the Act. The Coordinator General is the authority responsible for coordinating the EIS process for significant projects.

On 24 July 2006, the Coordinator-General declared Shute Harbour Marina Project a 'significant project' for which an EIS is required in accordance with Part 4 of the SDPWO Act. A Terms of Reference for the project was issued in May 2007.

3.2 Legislation Applicable to Marine Mammals

There are 45 species of Cetaceans (whales and dolphins) in Australia and one species of Dugong. Twenty-two of the whale and dolphin species found in Australian waters and the Dugong are listed in the Convention of Conservation of Migratory species to which Australia is a signatory, and hence are a listed migratory species under the EPBC Act.

Whilst in Queensland and Australian waters, the following legislation provides protection for marine mammal species:

- *Nature Conservation Act* 1992 (Qld);
  - *Nature Conservation (Wildlife) Regulation* 2006 (Qld);
  - *Nature Conservation (Dugong) Conservation Plan* 1999 (Qld);
  - *Nature Conservation (Whales and Dolphins) Conservation Plan* 1997 (Qld);
- *Fisheries Act* 1994 (Qld) (establishing Dugong Protection Areas);
- *Environment Protection and Biodiversity Conservation Act* 1999 (Commonwealth);
- *Great Barrier Reef Marine Park Act* 1975 (Protected Species, Species Conservation (Dugong Protection) Special Management Areas); and
- *Coastal Protection and Management Act 1995* (and its instruments);
  - State Coastal Management Plan;
  - The Mackay-Whitsunday Regional Coastal Management Plan (currently in draft format).

In addition to the above legislative framework, there are numerous other documents that outline management actions and recommendations relating to the conservation of marine mammals throughout Australia, Queensland and the Great Barrier Reef. These include:

- Blue, Fin and Sei Whale Recovery Plan 2005 – 2010 (DEH, 2005a);
- Humpback Whale Recovery Plan 2005 – 2010 (DEH, 2005b);
- Southern Right Whale Recovery Plan 2005 – 2010 (DEH, 2005c); and
- Turtle and Dugong Conservation Strategy for the Great Barrier Reef Marine Park (GBRMPA, 1994); and
- Draft Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park (GBRMPA, draft document).

As an EPBC Referral has been completed, and the project declared a "controlled action", no further permits or authorities are required with specific reference to marine mammals.

3.3 Legislation Applicable to Marine Turtles

Seven species of sea turtle are distributed throughout the world's tropical and temperate waters. All seven species are considered threatened and are protected under various national laws and international treaties. Australian and Queensland waters support populations of six of the seven species of sea turtles (Loggerhead, Green, Hawksbill, Flatback, Olive Ridley and the Leatherback).

Whilst in Queensland and Australian waters, the following legislation provides protection for turtle species:

- *Nature Conservation Act* 1992 (QLD);
  - *Nature Conservation (Wildlife) Regulation* 2006 (QLD);
- *Environment Protection and Biodiversity Conservation Act* 1999 (Commonwealth);

- *Great Barrier Reef Marine Park Act* 1975 (Protected Species);
- *Great Barrier Reef Marine Park Zoning Plan 2003* (Protected Species in the Great Barrier Reef Marine Park); and
- *Coastal Protection and Management Act 1995* (and its instruments);
  - State Coastal Management Plan;
  - The Mackay-Whitsunday Regional Coastal Management Plan (currently in draft format).

The conservation status of each of the six turtle species that occur in Australian waters are listed in Table 3.1.

TABLE 3.1 CONSERVATION STATUS OF SEA TURTLES OCCURRING IN AUSTRALIA

COMMON NAME	SCIENTIFIC NAME	IUCN (WORLD CONSERVATION UNION)	COMMONWEALTH ENVIRONMENT PROTECTION & BIODIVERSITY CONSERVATION ACT 1999	QUEENSLAND NATURE CONSERVATION (WILDLIFE) REGULATION 1994
Loggerhead	*Caretta caretta*	Endangered	Endangered	Endangered
Green	*Chelonia mydas*	Endangered	Vulnerable	Vulnerable
Hawksbill	*Eretmochelys imbricata*	Critically Endangered	Vulnerable	Vulnerable
Flatback	*Natator depressus*	Data deficient	Vulnerable	Vulnerable
Olive Ridley	*Lepidochelys olivacea*	Endangered	Endangered	Endangered
Leatherback	*Dermochelys coriacea*	Endangered	Vulnerable	Endangered

Source: Dobbs, 2001

In addition to the above legislative framework, there are numerous other documents that outline management actions and recommendations relating to the six sea turtle species throughout Australia, Queensland and the Great Barrier Reef, these include:

- Recovery Plan for Marine Turtles in Australia (Environment Australia, 2003);
- Marine Turtles in the Great Barrier Reef World Heritage Area (Dobbs, 2001);
- Bycatch of Sea Turtles in Longline Fisheries – Australia (Robins *et. al.,* 2002);
- Guidelines and conditions for marine reptile strandings, rehabilitation and release in New South Wales (NSWNPWS, 2002); and
- Turtle and Dugong Conservation Strategy for the Great Barrier Reef Marine Park (GBRMPA, 1994).

As an EPBC Referral has been completed, and the project declared a "controlled action", no further permits or authorities are required with specific reference to marine mammals.

No applications specific to marine megafauna are required for the development of SHMD. Any operators within the marina who may have an interest in marine megafauna (e.g. Whale watching) would be required to obtain their own permits for relevant activities.

4.0 EPBC LISTED MARINE MEGA FAUNA

Marine megafauna species listed in the EPBC Protected Matters Database are introduced in Table 4.1. A search of the Database was undertaken with respect to the project area. Table 4.1includes an assessment of the potential each species has to occur in the greater project region.

TABLE 4.1 EBPC LISTED MARINE MEGA FAUNA AS IDENTIFIED IN FROM EPBC PROTECTED MATTERS SEARCH.

SPECIES	EPBC ACT LISTING	SPECIES SUMMARY
Mammals		
Humpback Whale *Megaptera novaeangliae*	Vulnerable, Migratory, Cetacean	Likely to occur within the Whitsunday region but not likely to occur within project area Humpback Whales are found in the waters off Australia's Antarctic Territory. Within Australian waters there are two distinct populations, an east and west coast population. Humpback Whales feed in the Antarctic waters, migrating up the east and west coast of Australia to breed. The east coast population utilises the Whitsunday region as a breeding ground and are highly likely to be within the vicinity of the study area, however they are unlikely to occur within the waters of the project site.
Blue Whale *Balaenoptera musculus*	Endangered, Migratory, Cetacean	Not likely to occur within study area Blue Whales are found in the waters off Australia's Antarctic Territory and along the southern parts of the Australian coast. These are most likely to occur near the edge of the continental shelf rather than in inshore areas. They are unlikely to occur in the vicinity of the study area.
Bryde's Whale *Balaenoptera edeni*	Migratory, Cetacean	Not likely to occur within study area Byrde's Whale is found from the equator to 40°S and has been recorded from all Australian states except the Northern Territory. They are found in both oceanic and inshore environments feeding on shoaling fish such as anchovies and euphausiids.
Killer Whale, Orca *Orcinus orca*	Migratory, Cetacean	Not likely to occur in study area Killer Whales are found in all oceans from polar regions to the equator inhabiting oceanic and coastal waters. They are considered more common in cold, deep waters and associated with seal colonies. Killer whales are a top level carnivore and feed on fish, birds and mammals.
Minke Whale *Balaenoptera acutorostrata*	Cetacean	Not likely to occur in the study area Minke Whales are widely distributed throughout the world and make seasonal migrations from cold water feeding grounds to warmer breeding areas. The northern Great Barrier Reef is thought to potentially be a key locality for the species, often sighted there in the winter months. The whale is mostly oceanic but has been known to congregate in coastal locations.

SPECIES	EPBC ACT LISTING	SPECIES SUMMARY
Indo-Pacific Humpback Dolphin *Sousa chinensis*	Cetacean, Migratory	Potential to occur within the study area Humpback dolphins live in subtropical and tropical coastal and estuarine waters of Australia, generally restricted to waters less than 15m deep within 10km of the coast. Little is known about the dolphin, and there are no population estimates for the Whitsunday region. Based on the reduced number of sightings it is believed that population numbers are dropping. Habitat within the study area is consistent with the Humpback dolphins preferred habitat.
Snubfin Dolphin *Orcaella heinsohni*	Cetacean, Migratory	Potential to occur within the study area The Snubfin dolphin, formerly Irrawaddy dolphin, is endemic to Australian/Papua New Guinea waters. Within Australia it occurs in tropical coastal and estuarine waters, generally restricted to waters less than 15m deep within 10km of the coast. As such it is found within close association with the Indo-Pacific Humpback dolphin. Little is known about the dolphin and there are no population estimates for the Whitsunday region. Habitat within the study area is consistent with the Snubfin dolphins preferred habitat.
Common Dolphin *Delphinus delphis*	Cetacean	Not likely to occur within study area The common dolphin has been recorded from all states in Australia and can be found in all oceans throughout the world utilising temperate through to tropical waters. May be found in both inshore and offshore environs. There are no key localities within Australia for this dolphin which is highly mobile often moving large distances. They are opportunistic feeders, feeding on shoaling and pelagic fish and squid.
Risso's Dolphin, Grampus *Grampus griseus*	Cetacean	Not likely to occur in the study area The Risso's Dolphin is known in Australia from south-western Western Australia, south through to Queensland and may undertake seasonal migrations. Has been recorded from sub-antarctic waters through to tropical water and is generally considered as pelagic and oceanic, but may come inshore. Fraser Island in Queensland has the only known resident population of the dolphin in Australia.
Pantropical Spotted Dolphin *Stenella attenuata*	Cetacean	Not likely to occur in study area The Pantropical Spotted Dolphin is found in the Pacific, Indian and Atlantic oceans in tropical and sub-tropical waters. In Australia it has been recorded from New South Wales, north through to Western Australia. There are no known key localities within Australia. Generally pelagic and oceanic, but may be found on the shelf and continental slopes. They are often seen with other dolphin species (particularly Spinner Dolphin), tuna and sea birds. They generally feed in aggregations and their diet of pelagic fish and squid overlaps that of the Yellowfin Tuna.
Spotted Bottlenose Dolphin *Tursiops aduncus*	Cetacean	Likely to be transient throughout region Found from New South Wales, north of Port Macquarie through Queensland and the Northern Territory to Perth in Western Australia. Several key localities identified throughout Australia, none occurring in the Great Barrier Reef.

SPECIES	EPBC ACT LISTING	SPECIES SUMMARY
Bottlenose Dolphin *Tursiops truncatus s. str.*	Cetacean	Not likely to occur in study area Identified from Hervey Bay, Queensland south through to Albany in Western Australia. Several key localities identified throughout Australia, none occurring in the Great Barrier Reef.
Dugong *Dugong Dugon*	Migratory, Marine	Likely to occur within the study area Dugong are found in coastal waters of northern Australia. They are seagrass specialists, with major population occurring in areas where there are wide shallow protected bays, supporting healthy seagrass communities. It is likely that Dugong occur within the study area.
Reptiles		
Flatback Turtle *Natator depressus*	Vulnerable, Marine, Migratory	Potential to occur within study area Flatback Turtles are the only sea turtle endemic to Australia. The turtles are likely to utilise the study area as feeding and resting grounds. There are no known nesting grounds within the Whitsundays, and the closest nesting beach is located in Mackay.
Green Turtle *Chelonia mydas*	Vulnerable, Marine, Migratory	Potential to occur within study area The Green Turtle is a medium to large turtle found in tropical and subtropical waters throughout the world. They inhabit subtidal and tidal reefs and seagrass meadows, generally staying near the coastline and around islands. No significant nesting sites have been identified in the Whitsunday region. Green Turtles may potentially utilise the project area for feeding and resting grounds.
Loggerhead Turtle *Caretta caretta*	Endangered, Marine, Migratory	Potential to occur within study area Loggerhead Turtles are a large turtle with a similar distribution to Green Turtles; however they are also known to inhabit temperate waters. The eastern Australian population is the most significant population in the southern pacific ocean. Loggerhead turtles inhabit coral and rocky reefs, muddy bays, sandflats, estuaries and seagrass meadows such as those represented within the study area. Loggerhead turtles may potentially use the study area as a feeding and resting ground.
Hawksbill Turtle *Eretmochelys imbricata*	Vulnerable, Marine, Migratory	Potential to occur within study area Hawksbill Turtles are found throughout the world in tropical and subtropical waters. It is a relatively small turtle, which is commonly used in the 'Tortoise Shell' industry. They are often found in and around coastal reefs, rocky areas, estuaries and lagoons and may potentially utilise the study area as feeding and resting grounds.
Leatherback Turtle *Dermochelys coriacea*	Vulnerable, Marine, Migratory	Potential to occur within study area Leatherback Turtles are the largest marine turtle and have the widest world wide distribution, occurring in tropical, subtropical and temperate waters. They differ to other marine turtles in that the feed in temperate waters, moving to tropical and subtropical waters for breeding. There are no significant nesting localities for the Leatherback Turtle in Australia. Leatherback Turtles have the potential to occur within the vicinity of the study area.

SPECIES	EPBC ACT LISTING	SPECIES SUMMARY
Olive Ridley Turtle *Lepidochelys olivacea*	Endangered, Marine, Migratory	Potential to occur within study area Olive Ridley Turtles are the smallest marine turtle to inhabit Australian waters, and are the most abundant of all marine turtles. Australia supports low densities of breeding with the Northern Territory and the Gulf of Carpentaria, having the most significant Australian breeding sites. Olive Ridley Turtles have the potential to occur within the vicinity of the project site.
Estuarine (Saltwater) Crocodile *Crocodylus porosus*	Migratory	Potential to occur within study area Crocodiles are mostly estuarine, however they also occur on beaches and off shore islands in the Great Barrier Reef. The project site is within the geographic distribution of crocodiles and may potentially provide suitable habitat.
Sharks		
Whale Shark *Rhincodon typus*	Vulnerable	Not likely to occur within the study area The Whale Shark is the world's largest fish and one of only 3 filter feeding sharks. Whale Sharks make seasonal migration and within Australia critical habitat for this species lies on the west coast in Ningaloo Reef, Christmas Island and the Coral Sea. It is unknown if there are other critical habitats within Australian waters.
Grey Nurse Shark *Carcharias taurus*	Critically endangered (East coast population)	Not likely to occur within the study area Grey Nurse Sharks are often observed just above the sea bed in or near deep sandy-bottomed gutters or rocky caves in the vicinity of inshore rocky reefs and islands. Their distribution is now confined to coastal waters off southern Queensland, the entire New South Wales coast and the south-west coastal waters of Western Australia. Shute Harbour is well north of their current distribution.
Saw Fish *Pristis microdon*	Critically endangered	Not likely to occur within the study area Occurs mostly in fresh or brackish rivers in northern Australia, sometimes more than 100km inland. The Shute Harbour area does not contain fresh or brackish rivers preferred by this species.

5.0 MARINE MEGAFAUNA SPECIES PROFILES

This section describes marine megafauna species that occur in the Whitsunday region as identified from Table 4.1. The significance of the project site to theses species is also described. Table 5.1 summarises the whale, dolphin, dugong, turtle and crocodile species that could occur in or near Shute Bay or the Whitsunday area, along with their preferred habitat and conservation status.

While Shute Bay itself may present suitable habitat or food sources to some species, the bay is not considered to be of critical or high importance since usage of the area appears to be relatively low, possibly due to relatively sparse resources when compared to other areas within the Whitsunday region, as discussed in the following sections. Of particular importance is the understanding that no turtle nesting beaches occur in or near Shute Bay and no major breeding sites occur within the Whitsunday area.

TABLE 5.1 MARINE MEGAFAUNA LIKELY TO OCCUR IN SHUTE BAY AND WHITSUNDAY REGION, THEIR PREFERRED HABITAT AND CONSERVATION STATUS

COMMON NAME	SCIENTIFIC NAME	PREFERRED HABITAT	LIKELIHOOD OF OCCURRING IN SHUTE BAY (LOW, MOD, HIGH)	LIKELIHOOD OF OCCURRING IN WHITSUNDAY REGION (LOW, MOD, HIGH)	CONSERVATION STATUS: IUCN (COMMONWEALTH QUEENSLAND)
Humpback Whale	*Megaptera novaeangliae*	Pelagic	Low	High	Vulnerable Vulnerable Vulnerable
Dugong	*Dugong dugon*	Wide shallow protected coastal bays and channels, especially where seagrass occurs	Moderate	High	Vulnerable Migratory Vulnerable
Indo-Pacific Humpback Dolphins	*Sousa chinensis*	Coastal and estuarine waters	Low	Moderate	Data deficient Listed Rare
Snubfin Dolphin	*Orcaella heinsohni*	Coastal and estuarine waters	Low	Moderate	Insufficiently known Listed Rare
Flatback Turtle	*Natator depressus*	Turbid, soft bottom habitats	High	High	Data deficient Vulnerable Vulnerable
Green Turtle	*Chelonia mydas*	Sub-tidal and tidal reefs and seagrass meadows, in Coastal protected waters	High	High	Endangered Vulnerable Vulnerable

COMMON NAME	SCIENTIFIC NAME	PREFERRED HABITAT	LIKELIHOOD OF OCCURRING IN SHUTE BAY (LOW, MOD, HIGH)	LIKELIHOOD OF OCCURRING IN WHITSUNDAY REGION (LOW, MOD, HIGH)	CONSERVATION STATUS: IUCN (COMMONWEALTH QUEENSLAND)
Loggerhead Turtle	*Caretta caretta*	Coral and rocky reefs, muddy bays, sandflats, estuaries and seagrass meadows.	High	High	Endangered Endangered Endangered
Hawksbill Turtle	*Eretmochelys imbricata*	Coastal reefs, rocky areas, estuaries and lagoons	High	High	Critically Endangered Vulnerable Vulnerable
Leatherback Turtle	*Dermochelys coriacea*	Pelagic	Low	Moderate	Endangered Vulnerable Endangered
Olive Ridley Turtle	*Lepidochelys olivacea*	Pelagic juveniles Adults pelagic, but forage in soft bottomed, shallow protected waters.	Low	Moderate	Endangered Endangered Endangered
Estuarine (Saltwater) Crocodile	*Crocodylus porosus*	Estuaries	Moderate	High	Low Risk Migratory Vulnerable

5.1 MARINE MAMMALS

Marine mammals including whales, dugong and dolphins all have a presence within the Whitsunday region. In the majority of cases the more abundant and well known species have a reasonable amount of information available regarding the biology and ecology of these animals. However, there are several small cetacean species that may occur in the Whitsunday region where relatively little is known, for example the Indo-Pacific Humpback dolphin and the Australian Snubfin dolphin (formerly known as the Irrawaddy dolphin). Habitat requirements, distribution and abundance for these species are poorly understood, especially for inshore dolphin species such as Indo-Pacific humpback and Australian snubfin dolphins (Parra *et. al.*, 2006b). While there are recognised knowledge gaps in the scientific literature, this report incorporates the latest information regarding these species using unpublished, published and in-press material. The following sections detail only the species that are considered to realistically utilise the project area and inshore habitats of the Whitsunday region. Further species that have been identified in the region, or have a distribution that covers the region, but are not considered to realistically occur within inshore coastal waters of the Whitsundays are listed in Section 4.0.

5.1.1 Humpback Whale

5.1.1.1 Description

Humpback Whales (*Megaptera novaeangliae*) (Figure 5.1) are baleen whales, possessing plates of hair-like structures used to sieve prey from water taken into the mouth. They can grow to a maximum length of about 18 m and weigh up to 40-45 tonnes. They have a stocky body with a broad rounded head and are generally black in colour with white throat grooves. Females are usually larger than males of the same age. Southern hemisphere humpback whales are generally dark dorsally and white underneath with a white underside to their flippers. They have up to 22 throat grooves running along the belly from the chin to the navel. A distinguishing characteristic of this species is the very long pectoral flippers (about one-third of total body length). Humpback whales are also well known for their spectacular breaching behaviour (DEH, undated A).

Figure 5.1 Humpback Whale (Megaptera novaeangliae)

Source: Environmental Protection Agency. Image available at http://www.epa.qld.gov.au/nature_conservation/wildlife/native_animals/whales/

5.1.1.2 Distribution

Humpback whales can be found world wide and in Australia they are seen throughout the winter and spring months. Whales seen in Australia make an annual migration from their feeding grounds in Antarctic waters to warmer sub-tropical waters on the east and west coast of Australia for breeding. The Whitsunday islands and passage have been identified as a key area for breeding and resting grounds for humpback whales (Figure 5.2) (DEH, undated A).

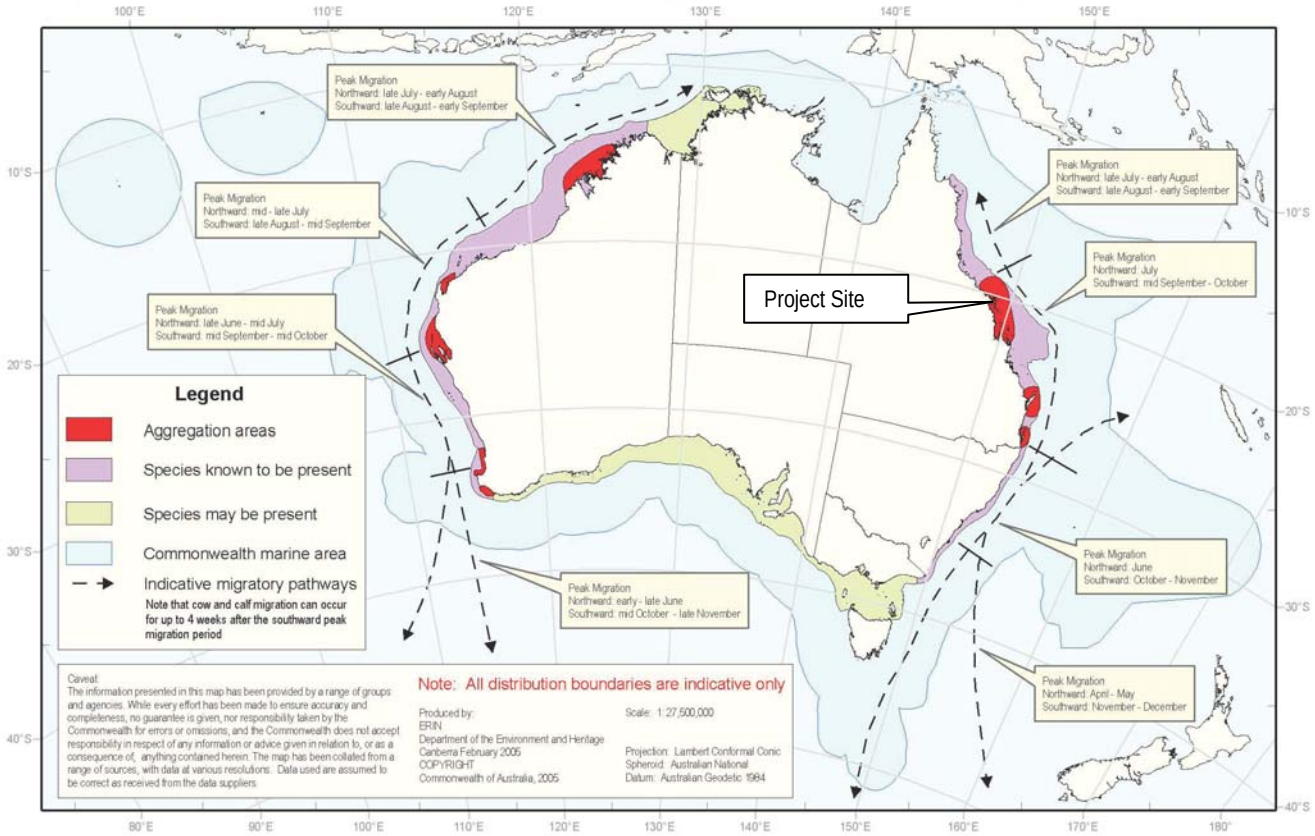

Figure 5.2 Distribution, migration and recognised aggregation areas of the Humpback Whale

Source: DEH, 2005b

5.1.1.3 Population

Australia has two migratory populations of humpback whales, a west coast and an east coast population. The east coast population is referred to as the Antarctic Area V Stock. Humpback whale populations were severely depleted through commercial whaling which ceased in 1963. At this stage the east coast whale population was estimated to be 5-6% of the pre-whaling population. It has been estimated that the pre-whaling east coast population was 27,000 individuals, this means by the time whaling ceased the east coast population had dwindled to approximately 1,500 individuals (DEH, 2005b). In 1996 the east coast population was estimated to be approximately 3,185 animals. This is a result of a steady population increase of approximately 12% per annum since 1981. Current estimates of the east coast population size are approximately 7,700 animals (Noad *et. al.*, 2004).

5.1.1.4 Habitat

Humpback whales are a highly migratory species. They inhabit Antarctic pelagic waters in summer for feeding and temperate–subtropical/tropical coastal waters in winter for breeding.

5.1.1.5 Diet

Humpback whales feed mainly in Antarctic waters almost exclusively on Krill. They have also been observed feeding on small shoaling fish and occasional benthic organisms. There are reports of feeding off Fraser Island.

5.1.1.6 Breeding

Humpback whales live for approximately 50 years and reach maturity between 5-10 years old. Their Antarctic feeding grounds are unsuitable for reproduction, so breeding occurs in warmer waters, such as the Whitsunday's, during the whale's yearly migrations. The gestation period for the Humpback is around 11 months and the calf is approximately 4 m long at birth, doubling in size within a year, at which stage it is weaned. The mother's milk has a high fat content and can produce up to 600 litres of milk a day, allowing for the calf to develop a thick layer of blubber for the migration back to the Antarctic feeding grounds. Although adult females can theoretically calve annually it is common for a one to two year interval between calves.

5.1.1.7 Threats

Threats to humpback whales include disturbance by human activities (including noise), collisions with vessels, and entanglement in lines and fishing gear.

Historically, the primary threat to whale populations was the commercial whaling industry. It is estimated that in 1963 when commercial whaling ceased in Australia, the humpback whale population size was 5-6% of that prior to whaling. Since the world-wide cessation of humpback whale commercial whaling in 1965, population numbers have been steadily increasing.

Current threats to the population include, whale watching and research vessels/aircraft, coastal seismic operations, defence operations, collision with large vessels (boat strike), entanglement in fishing gear/shark nets and marine pollution, including plastic debris, oil spills, dumping of industrial wastes leading to bioaccumulation to toxic substances (DEH, undated A).

5.1.1.8 Conservation Status

As a result of steady population increases, the humpback whale was downgraded from "Endangered" to "Vulnerable" in 1998 in the *Endangered Species Protection Act 1992* which was superseded by the EPBC Act. The *Nature Conservation (Wildlife) Regulation 2006* also lists the whale as "Vulnerable".

Due to their population vulnerability, the humpback whale is a cetacean species of high management priority in the Great Barrier Reef Marine Park, as noted in the *Draft Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park*. Humpback whales are a focus of whale watching activities within the park. Beyond this activity, increased humpback whale populations bring new challenges to managing multiple use parks where other industries have developed during a time when populations were depleted.

5.1.1.9 Significance of Project Site

The Whitsunday Islands and passage have been identified as a key area for breeding and resting grounds for humpback whales (DEH, 2005b). Humpback Whales may occur in the Whitsunday region during the winter migration to/from southern waters.

Humpback whales would not occur in Shute Bay or adjacent Molle Channel because of the shallow waters. It is possible they could pass outside the adjacent islands of Repair and Tancred. It is possible that passing humpback whales may encounter boat traffic that is serviced by the Shute Harbour Marina Development.

5.1.2 Dugong

5.1.2.1 Description

Dugong (*Dugong dugon*) (Figure 5.3) look similar to a rotund dolphin or seal, although they are less streamlined. They have short pectoral fins and their tail flukes are broad, similar to those of whales. Their head has a large, downward-pointing mouth. The body has a grey-bronze colouration, which is darker on the dorsal surface, than the ventral. Adult Dugongs can grow to lengths greater than 3 m and weigh in excess of 400 kg (GBRMPA, 1994).

Figure 5.3 Dugong (Dugong dugon)

Source: Great Barrier Reef Marine Park Authority. Image available at
http://www.gbrmpa.gov.au/corp_site/info_services/library/resources/image_collection/gbrmpa_image_library_search/

5.1.2.2 Distribution

In Australia, dugong are found from the Queensland / New South Wales border, north through to Shark Bay in Western Australia.

It is reported that dugong undertake small to large scale movements. These are categorized as Macro-scale (>100km), Meso-scale (15-100km) and Micro-scale (<15km) (Sheppard *et. al.*, 2006).

5.1.2.3 Population

Dugong populations have been monitored closely over the last 20 years through a series of aerial and boat surveys along the Queensland coast. The results of the 2005 survey indicate that dugong populations at the regional scale are stable, however, the populations of local communities fluctuate (Marsh *et. al.*, In review). However, a hind casting study indicates that dugong numbers have declined by more than 90% since 1962 (Marsh *et al.* 2005). The estimated population size of dugong in 2005, in 11 survey blocks along the urbanised Great Barrier Reef coast, between Bundaberg and Cairns, incorporating the Whitsunday Coast, was approximately 2580. This compares with 2294 in 1986/87, 1121 in 1992, 1177 in 1994, and 2519 in 1999 (Marsh *et al*. 2005).

The results of the 2005 survey do not give a population estimate for the Whitsunday region, this may be because there were not enough animals observed to estimate the population. This should not however, be taken as an indication that the area is not an important dugong area or that the population has diminished, but simply that at that time there were not a significant number of dugong in the area (Ivan Lawler, pers comm., 2006).

Previous population estimates for the Whitsunday region had up to 350 Dugongs (Marsh *et. al.*, In review). It has also been noted that while the southern Great Barrier Reef is estimated to have around 77% of the population of dugongs along the Queensland coast (Marsh *et. al.*, In review), dugongs in the central and southern Great Barrier Reef are sparsely distributed compared to populations found in the northern Great Barrier Reef (Marsh *et. al.*, 1992).

5.1.2.4 Habitat

Dugongs are seagrass specialists and frequent coastal waters. Major concentrations of Dugongs tend to occur in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands. Dugongs are also regularly observed in deeper water farther offshore in areas where the continental shelf is wide, shallow and protected (Marsh *et. al.*, 1992).

5.1.2.5 Diet

The diet of the dugong is made up of almost entirely seagrass. When accessible, dugong uproot the whole plant, otherwise eating just the leaves. It is believed that they may selectively forage for species that are easily digestible and have high nutrient contents, such and *Halodule* and *Halophila* species (Marsh *et. al.*, 1992). They have also been known to eat macro-algae and some marine invertebrates.

5.1.2.6 Breeding

The life-cycle of the dugong is an influential factor regarding the severity of impacts that human activities have on dugong populations. Dugongs are long lived (approximately 55 to 70 years) and slow maturing with the estimated time to maturity being between 6 and 17 years. The gestation period is between 13-15 months and when calves are born they are suckled for 14 to 18 months. The period between calving can be between 2.5 and 7 years (Marsh *et. al.*, 1992). Taking this cycle into account, the natural population growth of the dugong is estimated to be less than 5% per annum (Marsh *et. al.*, 1992). Hence dugong populations are susceptible to human induced impacts on population.

5.1.2.7 Threats

Dugong have a naturally low population growth rate due to their slow maturation, low birth rates and investment in their young. These attributes make dugong populations highly susceptible to both natural and anthropogenic influences. Anthropogenic impacts include: habitat loss and degradation, entanglement in fishing equipment, shark nets, boat strike, indigenous hunting and pollution (GBRMPA, 1994).

Natural threats include weather events which can effect the distribution and abundance of seagrass within important dugong feeding ground. One example of this was in Hervey Bay, 1992, where two floods and a cyclone destroyed approximately 1,000 km2 of seagrass. Before these events the dugong population in the area was the largest in Queensland. In the year following these events 99 dugong carcasses where found in the area showing signs of starvation and it is believed that this is an underestimate of mortality rates due to these events (Marsh *et. al.*, 1992).

Dugongs are also susceptible to a number of diseases including toxoplasmosis, a disease associated with domestic cats, and papilloma virus. Several dugongs have also been diagnosed as dying from toxoplasmosis in the Moreton Bay area (Blyde and Long, 2006).

Marsh *et. al.* (In review) have calculated the size of total sustainable human-induced dugong mortality (termed *Potential Biological Removal*; PBR) along the urban coast of Queensland is between 7 and 69, depending on the recovery factor used in the calculations.

5.1.2.8 Conservation Status

The global population of the dugong is considered "Vulnerable" by the IUCN. Dugongs in Australia are not listed as at risk of extinction under the EPBC Act. However, they are protected under the Act as migratory marine species. Dugongs are listed as vulnerable under the Queensland Nature Conservation (Wildlife) Regulation 2006 (NC Regulation).

There are two Dugong Protection Areas within the vicinity of Shute Harbour. These are at Repulse Bay (20km to the south) and Edgecumbe Bay (40km to the north). These areas limit fishing activity that could directly impact dugong.

5.1.2.9 Significance of Project Site

The project site at Shute Bay does not appear to provide regionally significant habitat or feeding resource to dugong. While the site contains preferred species of seagrass that dugong feed on, their cover is sparse (<0.5 %) within Shute Bay, with only small patches up to 5% cover as discussed in Section 0. More significant seagrass habitat occurs in other areas of the Whitsunday region as discussed in Section 0. Literature review did not reveal information indicating the use of Shute Bay by dugong. Feeding trails have not been observed by previous marine ecological studies within the bay (FRC Environmental 1999, 2008).

While significant habitat and food sources may not be present in Shute Bay, the project site may have indirect significance given its location between the Repulse Bay and Edgecumbe Bay Dugong Protection Areas. Dugong travelling between the two areas may be subject to boat strike or boating disturbance from general boating traffic within the increasingly popular Whitsunday region.

5.1.3 Indo-Pacific Humpback Dolphin

5.1.3.1 Description

Indo-Pacific humpback dolphins (*Sousa chinensis*) (Figure 5.4) are a medium sized dolphin up to 2.8m in length. Their dorsal fin is short, slightly recurved and triangular in shape. Humpback dolphins are generally grey, with flanks shading to off-white and spotting towards the ventral surface (Parra *et. al.*, 2004).

Figure 5.4 Indo-Pacific Humpback Dolphins (Sousa chinensis)

Source: Environmental Protection Agency. Image available at

http://www.epa.qld.gov.au/nature_conservation/wildlife/az_of_animals/indopacific_humpback_dolphin/

5.1.3.2 Distribution

Indo-Pacific humpback dolphins inhabit tropical and subtropical coastal waters from the Queensland / New South Wales border, north around to Ningaloo Reef in Western Australia (Figure 5.5) (DEH, undated B).

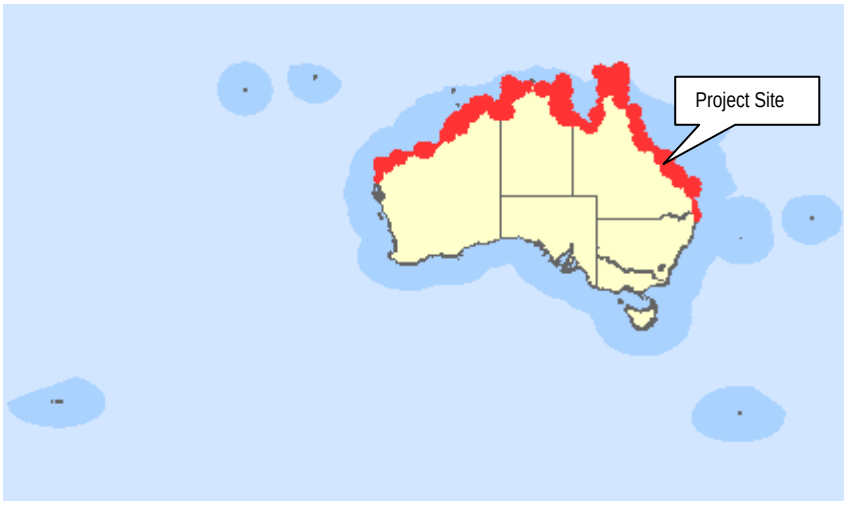

Figure 5.5 Australian distribution of Indo-Pacific Humpback Dolphin

Source: DEH, undated B

Legend: Red = distribution within Australian waters

5.1.3.3 Population

The only known population estimates are from Moreton Bay in South-east Queensland, and Cleveland Bay near Townsville. Parra *et. al.*, (2006a) suggests that less than 100 individuals occur in Cleveland Bay. Based on a decline in sightings of the dolphin across their range, it is believed that populations throughout its range are probably in decline (Parra *et. al.*, 2004). Population estimates within the Whitsunday region are unknown.

5.1.3.4 Habitat

Humpback dolphins live in coastal and estuarine waters often in waters less than 15 m deep within 10 km from the coast and within 20 km of the nearest river mouth (Parra *et. al.*, 2006b). These dolphins co-exist with another inshore dolphin species, the snubfin dolphin, likely through diet partitioning and interspecific aggression (Parra, 2006). Presence of the Humpback Dolphin for nearshore, estuarine areas may be related to their diet, but quantitative studies on their foraging ecology are limited. Available data suggests that they are opportunistic-generalist feeders, entering a wide variety of coastal estuarine and nearshore reef-associated fishes (Heinsohn 1979, Barros *et. al.*, 2004 cited in Parra *et. al.*, 2006b).

5.1.3.5 Diet

Humpback dolphins feed on fish, squid, cuttlefish and crustaceans such as prawns and krill. In Moreton Bay they are known to feed in association with prawn trawlers and it is assumed that this association occurs throughout their range (EPA, 2007a).

5.1.3.6 Breeding

There is very little known about the life-cycle of the Indo-pacific Humpback dolphin. It is believed that they can live to over 40 years and that sexual maturity occurs around the age of 10-13. The gestation, weaning and calving periods are not known with certainty (EPA, 2007a).

5.1.3.7 Threats

Due to their coastal/estuarine distribution, Humpback dolphins are particularly vulnerable to anthropogenic impacts (Parra *et. al.*, 2004). These threats may include various effects from the fishing industry (e.g., overfishing of prey items, incidental catch), pollution, boat strike, tourism and coastal development leading to habitat destruction and degradation, including noise pollution and harassment.

As with dugongs, Indo-pacific Humpback dolphins are susceptible to toxoplasmosis, a disease associated with domestic cats (Blyde and Long, 2006). Bowater *et. al.*, (2003; cited in Blyde & Long, 2006) described the deaths of four Indo-pacific humpback dolphins due to toxoplasmosis in Queensland.

5.1.3.8 Conservation Status

Very little is known about the biology and ecology of these dolphins and hence it is considered that there is not enough information to ascertain the conservation status of Indo-Pacific Humpback Dolphin populations in Australia. The IUCN has listed the Indo-Pacific Humpback Dolphin as “Data Deficient”, and under the EPBC Act it is a “Listed Migratory Species”. The NC Regulation identifies it as “Rare”.

The Humpback Dolphin is a cetacean species of high management priority in the Great Barrier Reef Marine Park, as noted in the *Draft Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park*. These coastal dolphins are susceptible to many human activities including boating, netting and run off resulting in degraded water quality.

5.1.3.9 Significance of Project Site

Based on a review of available literature, Humpback dolphins have not been recorded in the vicinity of Shute Bay. Given that they range up to 20 km from river mouths and the nearest river (Proserpine River) is about 40 km away, their presence in Shute Bay is not likely.

5.1.4 Snubfin Dolphin

5.1.4.1 Description

The snubfin dolphin (*Orcaella heinsohni*), formerly incorrectly identified as the Irrawaddy Dolphin, is a small to medium sized dolphin with length at maturity being around 2.3 – 2.7 m. The Snubfin has a large, blunt, rounded head with an indistinguishable beak. The dorsal fin is short, blunt and triangular, and the pectoral fins are long and broad. The Snubfin

is subtly three toned in colouration, with a dark back, white abdomen and intermediate light grey to brownish grey field on the side (Beasley *et. al.*, 2005).

Figure 5.6 Australian Snubfin Dolphin
Source: Environmental Protection Agency. Image available at:
http://www.epa.qld.gov.au/nature_conservation/wildlife/az_of_animals/australian_snubfin_dolphin/

5.1.4.2 Distribution

The snubfin dolphin is endemic to Australian/Papua New Guinean waters (cited in Parra *et. al.*, 2006). In Australian waters the snubfin dolphin is known from Gladstone, Queensland, north to Broome in Western Australia (DEH, undated C) (Figure 5.7).

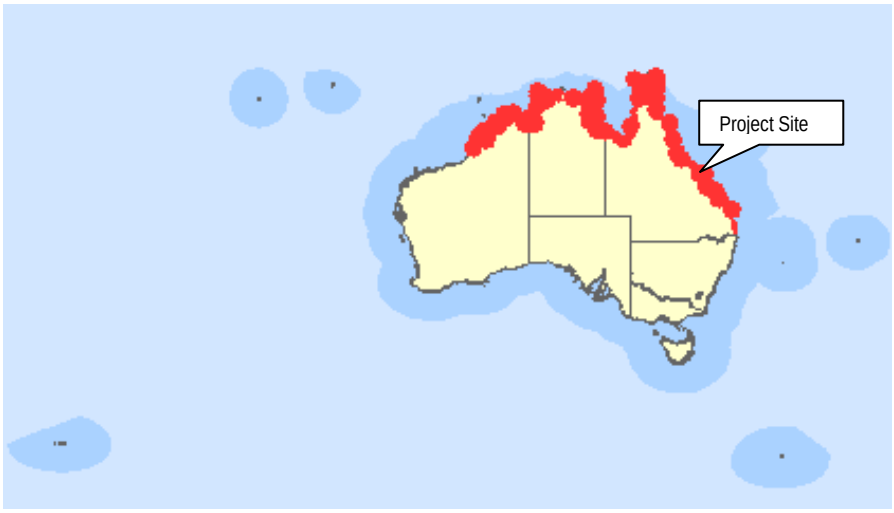

Figure 5.7 Australian distribution of Australian Snubfin Dolphin
Source: DEH, undated C
Legend: Red = distribution within Australian waters

5.1.4.3 Population

The only population estimate for the snubfin dolphin in Australian waters is from Cleveland Bay, near Townsville. Parra *et. al.,* (2006a) suggests that less than 100 individuals occur in Cleveland Bay.

There is little information of the structure of the populations of Snubfin, and it is believed that the species lives in genetically discrete populations. Based on the limited knowledge of other inshore dolphins and that of the Snubfin, it is believed that the populations are in decline (GBRMPA, draft).

5.1.4.4 Habitat

Snubfin dolphins inhabit coastal waters less than 15 m deep, up to 10 km from the coast and up to 20 km from the nearest river mouth (Parra *et. al.*, 2006b). They are not considered to be a migratory species (GBRMPA, draft). These dolphins co-exist with another inshore dolphin species, the Indo-Pacific Humpback Dolphin, likely through diet partitioning and interspecific aggression (Parra, 2006). Presence of the snubfin dolphin for nearshore, estuarine areas may be related to their diet, but quantitative studies on their foraging ecology are limited. Available data suggests that they are opportunistic-generalist feeders, entering a wide variety of coastal estuarine and nearshore reef-associated fishes (Heinsohn 1979, Barros *et. al.*, 2004 cited in Parra *et. al.*, 2006b).

5.1.4.5 Diet

From the analyses of stomach contents it has been shown that the Snubfin feeds predominantly on fish, squid, cuttlefish and various crustacean species, such as prawns (Ross 2006).

5.1.4.6 Breeding

Snubfin dolphins are believed to live to about 28 years. It is not known at what age the dolphins mature sexually or at what intervals they give birth. It is believed that the gestation period is around 14 months and the calves take approximately 2 years till they are weaned.

5.1.4.7 Threats

The major threats to the snubfin dolphin, as for most other marine mega fauna includes incidental capture in shark and barramundi nets, overfishing of prey species, pollution – particularly because of the species inshore habitat preference, presumed habitat destruction and degradation including noise pollution and harassment. Drowning in nearshore gill nets set across creeks, rivers, and shallow estuaries represents one of the major threats to nearshore dolphins along the Queensland coast (Paterson 1990, Hale 1997 Cited in Parra *et. al.,*, 2006). Snubfin dolphins appear to be the rarest of Queensland's coastal dolphins (Parra *et. al.*, 2002 cited in Parra *et. al.*, 2006).

5.1.4.8 Conservation Status

The IUCN has classified the snubfin dolphin as "Insufficiently Known". The snubfin dolphin is considered a protected species because it is a Cetacean under the EPBC Act, and under the NC Regulation it is classified as "Insufficiently known/ Data Deficient".

The snubfin dolphin is a cetacean species of high management priority in the Great Barrier Reef Marine Park, as noted in the *Draft Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park*. These coastal dolphins are susceptible to many human activities including boating, netting and run off resulting in degraded water quality.

5.1.4.9 Significance of Project Site

Based on the literature review, Snubfin dolphins have not been recorded in the vicinity of Shute Bay. Given that they range up to 20 km from river mouths and the nearest river (Proserpine River) is about 40 km away, their presence in Shute Bay is not likely.

5.2 MARINE TURTLES

5.2.1 Flatback Turtle

5.2.1.1 Description

Flatback turtles (*Natator depressus*) (Figure 5.8) were originally named after their carapace's flat appearance. The carapace is generally broad, round with upturned lateral margins, with a significantly different appearance to other Cheloniidae family turtles due to the lack of bony ridges on the carapace and its softer texture. Carapace colouring is usually yellow-grey to grey-green, with the plastron whitish to pale yellow. Flatbacks generally grow to 100cm and approximately 70-98kg in weight.

Figure 5.8 Flatback Turtle

Source: Environmental Protection Agency. Image available at
http://www.epa.qld.gov.au/nature_conservation/wildlife/threatened_plants_and_animals/vulnerable/flatback_turtle/

5.2.1.2 Distribution

Flatback turtles are the only sea turtle species endemic to Australia, however this species is also known to feed in the Indonesian Archipelago and Papua New Guinea (DEH, undated D) (Error! Reference source not found.). Individuals are known to migrate up to 1,300km (DEH, undated D). Flatback turtles utilise the Shute Harbour area and surrounds as feeding and resting grounds (QPWS, pers. comm. Ross Monash, 23 October 2006).

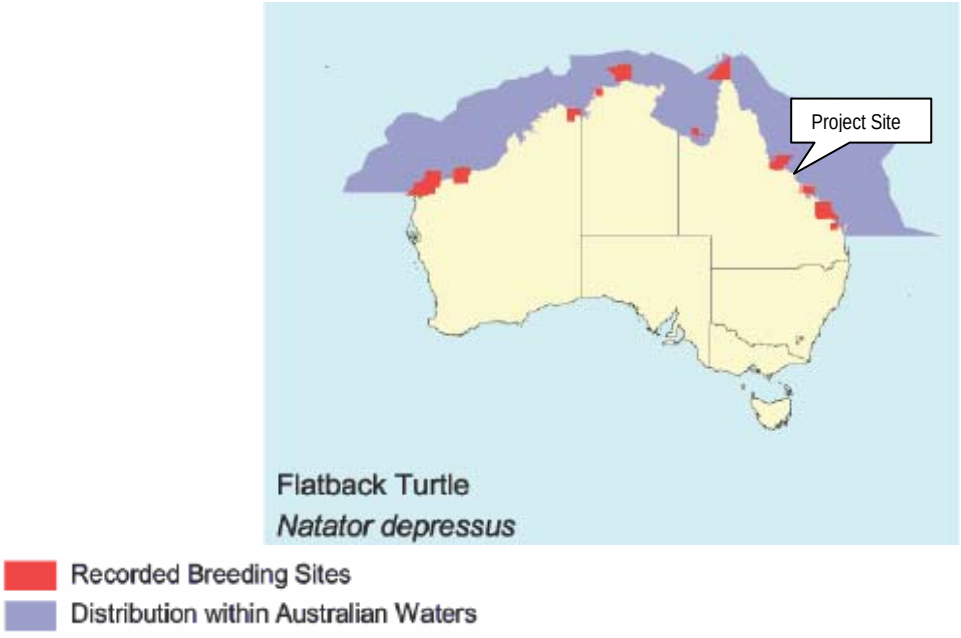

Figure 5.9 Breeding sites and distribution of Flatback Turtle in Australia

Source: Environment Australia (2003)

5.2.1.3 Population

The worldwide population of the flatback turtle is currently estimated to be approximately 20,000 nesting females (CCCSTSL, 2003a). As these turtle only nest in Australia this is also the Australian population of nesting females, refer Section 0. The east Queensland coast flatback turtle population appears to be stable (Limpus *et al.*, 2000).

5.2.1.4 Habitat

Flatback turtles are the only turtles that do not have an oceanic juvenile period. They inhabit soft bottomed environments and information from by-catch from trawlers suggest that they feed in turbid waters (DEH, undated D).

5.2.1.5 Diet

Adult turtles are benthic feeders. Their diet consists of cuttlefish, gastropods, hydroids, bryozoans, sea cucumbers, soft corals, jellyfish, prawns and seapens, other invertebrates and seaweed (CCCSTSL, 2003a; Reef CRC, undated; DEH, undated D).

5.2.1.6 Nesting and Breeding

Nesting sites for the flatback turtle only occur on Australian beaches with six areas identified as key nesting locations. Within southern Queensland, these areas are at Peak, Wild Duck and Curtis Islands (DEH, undated D). Low density nesting on mainland beaches and other islands occurs north of Gladstone, with the closest nesting beaches to the study area being located in Mackay. No significant nesting occurs in the Whitsundays. Nesting within the waters of the southern Great Barrier Reef occurs between October and January (GBRMPA, undated A).

5.2.1.7 Threats

Threats to the flatback turtle include capture, harvesting of eggs, destruction of nesting habitat, predation of eggs by feral pigs, lighting, pollution and entanglement in fishing equipment and shark nets (EPA 2007a, CCCSTSL, 2003a).

5.2.1.8 Conservation Status

Flatback turtles are considered "Data Deficient" by the IUCN. Within Australia they are considered "Vulnerable" under both the NC Regulation and the EPBC Act.

5.2.1.9 Recovery Actions

Under the *Environment Protection and Biodiversity Conservation Act 1999* the Department of Environment, Water, Heritage and the Arts has prepared a Recovery Plan for Turtles in Australia (2003). The actions in this plan aim to reduce the impact of threats and to increase survival rates, particularly of adults and large immature turtles that will soon become part of the breeding population. In general the recovery plan for marine turtles addresses the following issues:

- Reduce the mortality of marine turtles
- Bycatch of Marine Turtles in Fisheries
- Customary harvest by Aboriginal and Torres Strait Islander people
- Marine Debris
- Shark Control Activities
- Boat Strike
- Pearl Farming and Other Aquaculture Activities
- Defence Activities
- Develop programs and protocols to monitor marine turtle populations in Australian waters
- Monitor Key Populations and Stranded Marine Turtles
- Measuring Recovery
- Genetic Identification of Australian Marine Turtle Populations
- Manage factors that impact on successful marine turtle nesting
- Light Pollution
- Tourism and Recreational Activities
- Vehicle Damage
- Faunal Predation of Marine Turtle Eggs
- Identify and protect habitats that are critical to the survival of marine turtles
- Land Use and Water Quality
- Loss of Sea Grass or Benthic Habitat
- Oil Spills and Operational Discharges
- Noise
- Communicate the results of recovery actions and educate stakeholders
- Communicating Results of Recovery Actions
- Education, Public Awareness and Community Involvement
- Indigenous coastal community network
- Conserve shared marine turtle populations in the Asia/Pacific Region
- Marine Turtle Conservation in the Asia/Pacific Region

The recovery plan the actions detailed apply to all six species of marine turtle that occur in Australian waters.

5.2.1.10 Significance of Project Site

Flatback turtles utilise the Shute Harbour area and surrounds as feeding and resting grounds (QPWS, pers. comm. Ross Monash, 23 October 2006).

While Shute Bay provides suitable habitat and food sources, similar habitat and resources are widely distributed throughout the Whitsunday region as discussed in Section 2.0; therefore Flatback Turtles are considered unlikely to be highly dependant on the project area.

Shute Bay and adjacent beaches are not known to support turtle nesting.

5.2.2 Green Turtle

5.2.2.1 Description

The Green Turtle (*Chelonia mydas*) (Figure 5.10) is a medium to large sized turtle (up to 153cm, 100kg). Head is small and blunt with a serrated jaw. Carapace is bony without ridges and has large, non-overlapping, scutes (scales). Body is nearly oval, the carapace color varies from pale to very dark green and plain to very brilliant yellow, brown and green tones with radiating stripes (CCCSTSL, 2003b).

Figure 5.10 Green Turtle

Source: Environmental Protection Agency. Image available at:
http://www.epa.qld.gov.au/nature_conservation/wildlife/az_of_animals/green_turtle/

5.2.2.2 Distribution

Green Turtles are found throughout the world in tropical and sub-tropical waters. Within Australia they are found between southern New South Wales, north through to Shark Bay in Western Australia.

Figure 5.11 Breeding sites and distribution of Green Turtle in Australia

Source: Environment Australia (2003)

5.2.2.3 Population

The worldwide population estimate for breeding female turtles is 88,500 (CCCSTSL, 2003b). Within the Great Barrier Reef there are two distinct populations, northern and southern. The Whitsunday region is included in the southern population. The population estimate for the southern population is approximately 5,000 breeding females (GBRMPA undated B; DEH, undated E).

5.2.2.4 Habitat

Green Turtles inhabit sub-tidal and tidal reefs and seagrass meadows throughout their distribution generally staying near the coastline and around islands, living in bays and protected shores (EPA 2007c, GBRMPA undated B).

5.2.2.5 Diet

They are mostly herbivorous during adulthood feeding on algae, seagrass, mangrove fruit and occasionally jellyfish (GBRMPA, undated B). Green turtles can move great distances between their foraging grounds and breeding grounds (up to 2,600km) and as such the two different genetic groups can be found foraging in the same location (DEH, undated E).

5.2.2.6 Nesting and Breeding

Nesting occurs between October and March. Nesting locations extend from southern Queensland along the Queensland coast with important nesting grounds for the southern population located within the Capricorn/Bunker Group of islands (EPA 2007c, GRBMPA undated B), approximately 600km to the south of the project site. Low density nesting also occurs on many islands and mainland beaches through out the region. Based on available literature and communication with experts, there are no significant nesting grounds identified in the Whitsunday region.

5.2.2.7 Threats

The greatest threat to green turtles worldwide is from the harvest for eggs and food. Other green turtle parts are used for leather and small turtles are sometimes stuffed for curios. Within Australia, the most common causes of turtle deaths are

propeller strike, disease and entanglement (Greenland *et al*., 2004) as well as pollution and changes to important turtle habitats including coral reefs, seagrass beds, mangrove forests and nesting beaches (EPA 2007c). Incidental catch in commercial prawn trawling is an increasing source of mortality (CCCSTSL, 2003b).

5.2.2.8 Conservation Status

The green Turtle is listed as "Endangered" by the IUCN and "Vulnerable" by the EPBC Act and NC Regulation.

5.2.2.9 Recovery Actions

Refer to Section 5.2.1.9.

5.2.2.10 Significance of Project Site

Green turtles are known to utilise Shute Bay and the surrounding waters as foraging and resting grounds (QPWS, pers. comm. Ross Monash, 23 October 2006). Three adult green turtles were observed during a one day reconnaissance survey of the bay for the original EIS, by Connell Wagner (pers.comm. Shannah Brown, ex-Connell Wagner, 11 January 2007). While sparse in cover, the dominant seagrasses of Shute Bay, *Halophila ovalis* and *Halodule uninervis* are the preferred foraging species for Green Turtles. Green turtles also feed on the propagules of the mangrove *Avicennia marina*, which are likely to be seasonally common in the bay.

While Shute Bay provides suitable habitat and food sources for green turtles, it is not identified as being of particular significance within the Whitsunday region given the presence of similar or better resources elsewhere, refer to Section 2.0.

Shute Bay and adjacent beaches are not known to support turtle nesting.

5.2.3 Loggerhead Turtle

5.2.3.1 Description

The Loggerhead turtle (*Caretta caretta*) (Figure 5.12) is very large with heavy-set, strong jaws. Carapace is bony without ridges and has large, non-overlapping, rough scutes (scales). Carapace is heart shaped and is a reddish-brown with a yellowish-brown plastron (CCCSTSL, 2003a).

Figure 5.12 Loggerhead Turtle

Source: Environmental Protection Agency. Image available at:

http://www.epa.qld.gov.au/nature_conservation/wildlife/native_animals/loggerhead_turtle/

5.2.3.2 Distribution

As with the green turtle, Loggerhead turtles are found throughout the world in tropical and sub-tropical waters. Loggerhead turtles however, also extend their range to include temperate waters and have been recorded in coastal waters from all states within Australia (DEH, undated F). The majority of turtles are however, found within the waters of Queensland, north through to Shark Bay in Western Australia. Loggerhead turtles utilise the study area and surrounds as foraging and resting grounds (QPWS, pers. comm. Ross Monash, 23 October 2006).

Figure 5.13 Breeding sites and distribution of Loggerhead Turtle in Australia

Source: Environment Australia (2003)

5.2.3.3 Population

The eastern Australian population of the Loggerhead turtle is the most significant population in the southern Pacific Ocean (DEH, undated F). This population has declined by an estimated 50 - 80 % in the last 10 to 15 years. It is estimated that approximately 1,000 females nest each season in Queensland (DEH, undated F).

5.2.3.4 Habitat

Adult Loggerhead turtles inhabit coral and rocky reefs, muddy bays, sandflats, estuaries and seagrass meadows (EPA 2007d, GBRMPA undated C).

5.2.3.5 Diet

Loggerhead turtles are carnivorous and feed primarily on benthic invertebrates (DEH, undated F) and as with green turtles migrate between foraging and breeding grounds.

5.2.3.6 Nesting and Breeding

The most significant nesting location within Queensland is located in the Capricorn/Bunker group of islands, Swains group and Woongara coast on the mainland. These nesting locations are the only significant breeding grounds in the south Pacific region (GBRMPA, undated C) and are located approximately 600km south of the project site.

5.2.3.7 Threats

The greatest threat to Loggerhead turtles is the loss of nesting habitat due to coastal development, predation of nests, and human disturbances (such as coastal lighting and housing developments) that cause disorientations during the

emergence of hatchlings. Other major threats include incidental capture in prawn trawling and pollution. Prawn trawling is thought to have played a significant role in the recent population declines observed for the Loggerhead Turtle (EPA, 2007d, CCCSTSL, 2003c).

5.2.3.8 Conservation Status

The IUCN has classified the Loggerhead turtle as "Endangered" and it is classified as "Endangered" by the EPBC Act and the NC Regulation.

5.2.3.9 Recovery Actions

Refer to Section 5.2.1.9.

5.2.3.10 Significance of Project Site

Loggerhead turtles are known to utilise Shute Bay and surrounds as foraging and resting grounds (QPWS, pers. comm. Ross Monash, 23 October 2006). The range of nearby reefs and intertidal habitats provides suitable feeding ground for the Loggerhead turtle.

While Shute Bay provides suitable habitat and food sources for Loggerhead, it is not identified as being of particular significance within the Whitsunday region given the presence of similar or better resources elsewhere, refer to Section 2.0.

Shute Bay and adjacent beaches are not known to support turtle nesting.

5.2.4 Hawksbill Turtle

5.2.4.1 Description

The Hawksbill turtle (*Eretmochelys imbricata*) (Figure 5.14) is one of the smaller sea turtles. Carapace is bony without ridges and has large, over-lapping scutes (scales) and elliptical in shape. The carapace is orange, brown or yellow and hatchlings are mostly brown with pale blotches on scutes. The Hawksbill turtle is the one in which the "Tortoise Shell" industry utilises (CCCSTSL, 2003d).

Figure 5.14 Hawksbill Turtle

Source: Environmental Protection Agency. Image available at:

http://www.epa.qld.gov.au/nature_conservation/wildlife/az_of_animals/hawksbill_turtle/

5.2.4.2 Distribution

Hawksbill turtles are found in all oceans throughout the world with the majority inhabiting tropical and sub-tropical waters. In Australia the Hawksbill turtle's range extends from central Queensland through to Shark Bay in Western Australia and there are two genetically different populations. Hawksbill turtles are likely to utilise the study area and surrounds for foraging and resting (QPWS, pers. comm. Ross Monash, 23 October 2006).

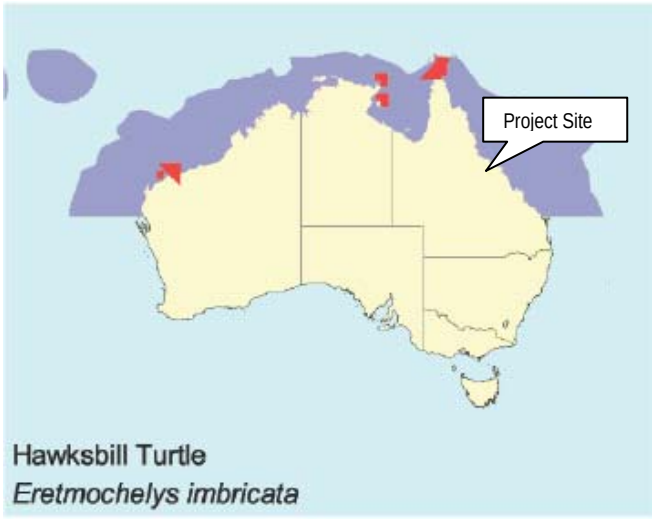

Figure 5.15 Breeding sites and distribution of Hawksbill Turtle in Australia

Source: Environment Australia (2003)

5.2.4.3 Population

Current estimates of the number of nesting females annually are: greater than 2,000 in the northern GBR and Torres Strait, approximately 1,000 in Arnhem Land and 1-2,000 in WA. Australia holds the last remaining large rookeries in the world (DEH, undated G).

5.2.4.4 Habitat

Hawksbill turtles inhabit tropical and sub-tropical waters. They are often found in and around coastal reefs, rocky areas, estuaries and lagoons (EPA, 2007e, GBRMPA, undated D).

5.2.4.5 Diet

Adult Hawksbill turtles are benthic foragers around coral and rocky reefs of tropical and sub-tropical waters. Hawksbill's are omnivores and feed on sponges, hydroids, cephalopods, gastropods, jellyfish, seagrass and algae (DEH, undated G).

5.2.4.6 Nesting and Breeding

Nesting along the east coast of Australia occurs north of Princess Charlotte Bay and is considered as one of the most important breeding localities world wide (DEH, undated G; GBRMPA, undated D).

These turtles also move great distances between foraging and breeding grounds, however there is no evidence of interbreeding between the different genetic populations (DEH, undated G; GBRMPA, undated D).

5.2.4.7 Threats

As with all marine turtles a major threat to populations is pollution and changes to important turtle habitats (EPA, 2007e). The greatest threat to Hawksbill turtles is harvesting for their prized shell, often referred to as "tortoise shell". In some countries the shell is still used to make hair ornaments, jewelry, and other decorative items (EPA, 2007e, CCCSTSL, 2003d).

5.2.4.8 Conservation Status

The Hawksbill turtle is classified by the IUCN as “Critically Endangered”, and “Vulnerable” under the EPBC Act and the NC Regulation.

5.2.4.9 Recovery Actions

Refer to Section 5.2.1.9.

5.2.4.10 Significance of Project Site

Hawksbill turtles are likely to utilise the study area and surrounds for foraging and resting (QPWS, pers. comm. Ross Monash, 23 October 2006). A single individual was observed within Shute Bay during a one day reconnaissance survey of the bay for the original EIS, by Connell Wagner (pers. comm. Shannah Brown, ex-Connell Wagner, 11 January 2007). The range of nearby reefs and intertidal habitats provides suitable feeding ground for the Hawksbill turtle.

While Shute Bay provides suitable habitat and food sources for Hawksbill turtles, it is not identified as being of particular significance within the Whitsunday region given the abundance of similar or better resources throughout the region, refer to Section 2.0.

Shute Bay and adjacent beaches are not known to support turtle nesting.

5.2.5 Leatherback Turtle

5.2.5.1 Description

The leatherback turtle (*Dermochelys coriacea*) (Figure 5.16) is the largest of the marine turtles reaching an average of 1.6m. They are the only turtle that do not have a hard carapace, instead they have an unscaled, keeled carapace with seven distinct ridges running the length of the animal. The carapace is dark grey or black with white or pale spots, while the plastron is whitish to black and marked by 5 ridges. All flippers are without claws. The head has a deeply notched upper jaw with 2 cusps (CCCSTSL, 2003e).

Figure 5.16 Leatherback Turtle (Dermochelys coriacea)

Source: Caribbean Conservation Corporation and Sea Turtle Survival League. Image available at:

http://www.cccturtle.org/sea-turtle-information.php?page=leatherback

5.2.5.2 Distribution

Leatherback turtles have the widest world wide distribution of all turtles. They occur in tropical, sub-tropical and temperate waters throughout the world. In Australia the leatherback turtle has been recorded from all states and is known to feed within the Great Barrier Reef Marine Park (GBRMPA, undated E).

Figure 5.17 Breeding sites and distribution of Leatherback Turtle in Australia

Source: Environment Australia (2003)

5.2.5.3 Population

The worldwide population estimate is approximately 35,860 nesting females (CCCSTSL, 2003e). As discussed below, there are no major breeding localities in Australia for the leatherback turtle, hence there are no population estimates for animals that utilise Australian waters.

5.2.5.4 Habitat

Leatherback turtles are different to others, in that they forage in temperate waters, generally only utilising tropical or sub-tropical environments for breeding. The leatherback is pelagic during its juvenile years, however, adults of the species are also predominantly pelagic, but have been known to feed in coastal areas (CCCSTSL, 2003e).

5.2.5.5 Diet

Leatherbacks have delicate, scissor-like jaws. Their jaws would be damaged by anything other than a diet of soft-bodied animals, so they feed almost exclusively on jellyfish, salps and squid (CCCSTSL, 2003e).

5.2.5.6 Nesting and Breeding

There are no major leatherback breeding sites located within Australian waters, however there are isolated sites where breeding does occur. It is estimated that there are less than 10 turtles that breed in Australia each year. No nesting of leatherbacks has been recorded in the last 10 years in Queensland. It is believed that turtles foraging in Australian waters probably breed in Papua New Guinea, Solomon Islands and Irian Jaya (EPA, 2007f, DEH, undated H).

5.2.5.7 Threats

The major threats to leatherback turtles are incidental catch from fishing activities and marine pollution such as plastic bags which are mistaken for jellyfish (CCCSTSL, 2003e).

5.2.5.8 Conservation Status

The leatherback turtle is listed as “Critically Endangered” by the IUCN, “Vulnerable” under the EPBC Act, and “Endangered” under the NC Regulation.

5.2.5.9 Recovery Actions

Refer to Section 5.2.1.9.

5.2.5.10 Significance of Project Site

Leatherback turtles are primarily pelagic but occasionally feed in coastal areas. Leatherbacks also generally feed in temperate waters, moving to sub- tropical and tropical waters, such as those at Shute Bay, for breeding. Based on these lifestyle characteristics Leatherbacks are unlikely to feed in the tropical waters of Shute Bay. In addition Shute Bay is not known to support any turtle nesting and as such it is unlikely that turtle would occur in the vicinity of the project site at Shute Bay.

5.2.6 Olive Ridley Turtle

5.2.6.1 Description

The Olive Ridley turtle (*Lepidochelys olivacea*) (Figure 5.18) is the smallest turtle found within Australian waters with the average adult having a carapace length of approximately 70cm. The carapace is bony without ridges and is almost circular and smooth with large scutes. Adults are olive-grey in colour (DEH, undated I).

Figure 5.18 Olive Ridley Turtle

Source: Environmental Protection Agency. Image available at

http://www.epa.qld.gov.au/nature_conservation/wildlife/native_animals/pacific_ridley_turtle_olive_ridley/

5.2.6.2 Distribution

The Olive Ridley turtle is found in tropical and sub-tropical waters throughout the Pacific and Indian Oceans. Within Australia they are found from southern Queensland / New South Wales, north through to Joseph Bonaparte Gulf in Western Australia (GBRMPA, undated F).

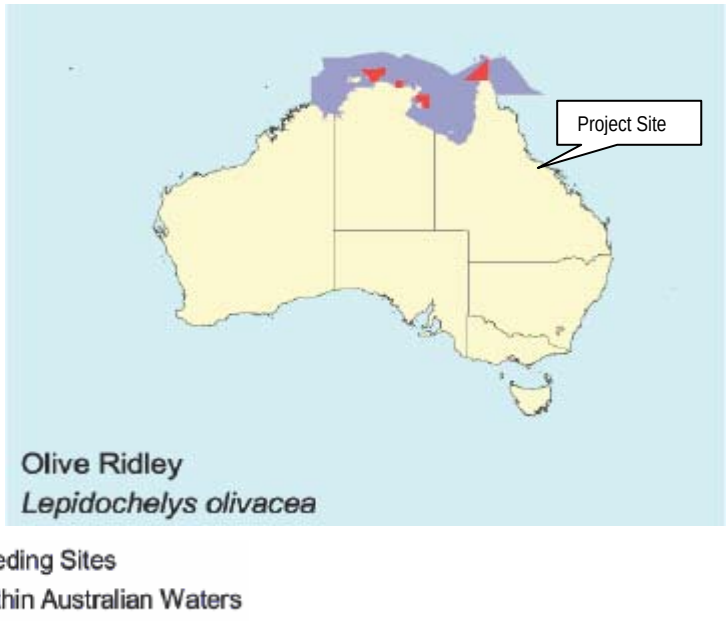

Figure 5.19 Breeding sites and distribution of Olive Ridley Turtle in Australia

Source: Environment Australia (2003)

Note: The distribution extends to southern Queensland/New South Wales, not as depicted in this Figure.

5.2.6.3 Population

The Olive Ridley is considered the most abundant of the sea turtles with a worldwide population estimated at 800,000 nesting females (CCCSTSL, 2003f). Australia has some low density nesting areas with the nesting population of females estimated to be between 500-1000 (GBRMPA, undated F).

5.2.6.4 Habitat

Post-hatchlings and small juvenile turtles occur in the surface waters of the open ocean. Large juveniles and adults of this species have been recorded in both benthic and pelagic foraging habitats (DEH, undated I). Adult Olive Ridley turtles are generally found foraging in soft bottomed, shallow protected waters.

5.2.6.5 Diet

They have powerful jaws that help them feed on benthic molluscs, crabs, shellfish, echinoderms and gastropods (EPA, 2007g, CCCSTSL, 2003f).

5.2.6.6 Nesting and Breeding

There are two predominant breeding localities in Australian waters, one in the Northern Territory and the other in the Gulf of Carpentaria. There are no known breeding/nesting sites within the Great Barrier Reef Marine Park (GBRMPA, undated F).

5.2.6.7 Threats

The major threats to this species around the world is direct harvest of adults and eggs, incidental catch from fishing activities and loss of nesting habitat (CCCSTSL, 2003f).

5.2.6.8 Conservation Status

The IUCN, EPBC Act and NC Regulation classify the Olive Ridley as "Endangered".

5.2.6.9 Recovery Actions

Refer to Section 5.2.1.9.

5.2.6.10 Significance of Project Site

Olive Ridley turtles may occur in the Shute Harbour region, including the project site, as the shoreline provides suitable habitat, being soft bottomed, shallow protected waters. The project site at Shute Bay is not likely to be of higher significance than other areas within the Whitsunday region based on resources available and a review of available literature.

Shute Bay and adjacent beaches are not known to support turtle nesting.

5.3 CROCODILES

5.3.1 Saltwater Crocodile

5.3.1.1 Description

An average size male Saltwater crocodile (*Crocodylus porosus*) may be between 3 and 4 m long and weigh between 200 and 300kg. The skin of the crocodile may vary between dark brown through to grey and olive-brown, with dark mottling, depending on where it lives (Figure 5.20).

Figure 5.20 Saltwater Crocodile
Source: Environmental Protection Agency. Image Available at:
http://www.epa.qld.gov.au/nature_conservation/wildlife/native_animals/living_with_wildlife/crocodiles/estuarine_crocodile/

5.3.1.2 Distribution

Saltwater crocodiles are found from India to northern Australia and across to Vanuatu and the Solomon Islands. Crocodiles in Queensland occur between Gladstone and Cape York Peninsula (EPA, 2006). The closest crocodile population to Shute Harbour is the Proserpine River approximately 40 km to the south-west.

5.3.1.3 Population

Crocodiles have been protected in Australia since the 1970s after hunting reduced the species to an endangered level. In Northern Territory alone, there are estimated to be more than 60,000 crocodiles (comprising eggs, young and adults) and numbers are being actively managed. The nearest significant crocodile population to the project site is located at the Proserpine River approximately 40km to the south-west. The Draft Mackay-Whitsunday Regional Coastal Management Plan (2006) identifies the Proserpine River as "significant saltwater crocodile habitat" with significant nesting occurring within this area.

5.3.1.4 Habitat

Crocodiles are mostly estuarine, generally seen in the tidal reaches of rivers. They also occur on beaches and off shore islands in the Great Barrier Reef and in freshwater lagoons, rivers, and swamps. Although generally associated with coastal environs, the crocodile can occur hundreds of kilometres inland from the coast (EPA, 2006).

5.3.1.5 Diet

Crocodiles are carnivorous, with hatchlings predating on small insects, crabs, and prawns. As the crocodile grows it moves to larger prey items such as fish, frogs, snakes, birds and rats. A full grown crocodile may eat anything that it can overpower including pigs, kangaroos, goannas, cattle and turtles (EPA, 2006).

5.3.1.6 Nesting and Breeding

Female Australian saltwater crocodiles reach sexual maturity at 10-12 years and males at 17 years. Mound nests are made between November and April, and 40-70 eggs are laid. If the nest is around 32° C, the majority of the eggs will become male. Above or below that and they are predominately females. The eggs hatch after 90 days. It is estimated that only 1% of the hatchlings survive to maturity (EPA, 2006).

5.3.1.7 Threats

Habitat destruction is considered a major threat to crocodile survival in Queensland. Increasingly, humans are crowding in on crocodile territory — developments in swamps, mangroves and rivers are displacing crocodiles from their homes.

Public antagonism towards crocodiles is also increasing. The growing human population along the east coast of Queensland ultimately means more frequent encounters with crocodiles. Unless the community values crocodiles and their habitats, it will be a challenge to ensure their long-term conservation (EPA, 2006).

5.3.1.8 Conservation Status

The saltwater crocodile is listed as "Low Risk" by the IUCN, and a "Migratory" species under the EPBC Act. Under the NC Regulation it is listed as "Vulnerable".

5.3.1.9 Significance of Project Site

The project site is within the distribution range of crocodiles and therefore crocodiles may occur within the vicinity of the project site. It is understood that crocodiles have occasionally been sighted in the vicinity of the Laguna Quays marina near Proserpine, to the south of the Shute Harbour Marina Development. There is potential then, for crocodiles to be in the vicinity of the marina and present a safety threat to marina users.

Any crocodile that presents a persistent threat to users of the marina may need to be relocated. Any such relocation is to be managed under the requirements of the *Nature Conservation (Estuarine Crocodile) Conservation Plan* 2007.

6.0 SURVIVAL PRESSURES

6.1 INTRODUCTION

Natural and anthropogenic factors contribute significantly to marine turtle and dugong mortality. These pressures affect all sea turtle life stages, with natural mortality being considerable during hatchling and juvenile phases, while human-related impacts cause significantly higher rates of mortality during the adult life stage. These pressures, in relation to life stages are similar for dugong, dolphins and whales.

6.2 NATURAL

Numerous natural factors negatively influence marine megafauna population numbers. These factors include natural predators, cyclones, natural disasters and disease. These factors contribute to background mortality levels, allowing "…sufficient numbers of animals to survive to replace those that die…" thereby maintaining the population (GBRMPA, undated G).

6.3 ANTHROPOGENIC

Anthropogenic pressures influence the mortality rates of marine megafauna throughout the world. Threats include impacts from both terrestrial and aquatic environments and in many cases have led to diminishing population numbers of megafauna throughout international and Australian waters. Pressures / threats to populations in Australian waters include:

- Boat strike and disturbance;
- Habitat degradation (including coastal development);
- Disease (as result of human activities e.g. fibropapilloma in turtles);
- Fishing activities (especially those not utilising excluder devices);
- Marine pollution/debris;
- Feral and domestic animals (e.g. pigs, foxes, cats, dogs, etc);
- Defence activities (underwater explosions, etc);
- Indigenous hunting; and
- Illegal activities (e.g. poaching).

Marine megafauna are slow to mature and have naturally low birth rates (or low survival rates). This makes them particularly susceptible to anthropogenic impacts such as those discussed in the following sections (Marine and Coastal Committee, 2005). Also, due to their coastal/estuarine distribution, species such as Snubfin and Indo-Pacific Humpback dolphins (and other coastal marine species) are particularly vulnerable to anthropogenic impacts (Parra *et. al.*, 2004).

6.4 MARINE MEGAFAUNA DEATHS

From the EPA Marine Wildlife Stranding and Mortality Database Annual Reports, marine megafauna deaths in the Whitsunday region during 2005 have included:

- 1 Dugong; and
- 1 unidentified dolphin.

Over the last 10 years the number of deaths in the Whitsunday region has been:

- 20 Dugong
- 1 dolphin

The causes of these individual deaths are not described in the annual reports and could be the result of either natural or anthropogenic causes.

Significant anthropogenic threats to megafauna in Australian waters are discussed in further detail in Section 7.0 and how these relate to the project site is discussed in Section 9.0.

7.0 POTENTIAL ANTHROPOGENIC IMPACTS

As briefly discussed in Sections 5.0 and 6.3, numerous human-related impacts currently threaten sea megafauna populations throughout the world's oceans. Impacts include:

- artificial lighting;
- water quality degradation;
- habitat degradation;
- food source loss;
- four wheel driving on turtle nesting beaches;
- coastal development;
- beach armouring;
- beach nourishment;
- sand mining;
- marine construction;
- boating;
- boat strike;
- dredging;
- underwater explosions;
- oil spills;
- marine debris (through entanglement and ingestion);
- chemical pollution;
- fisheries and incidental capture;
- indigenous hunting;
- direct take of adults and turtle eggs by 'poachers'; and
- predation by domestic and feral animals.

An assessment of the risks posed by each of these potential impacts in relation to the Shute Harbour Marina Development provides the basis for determining significant impacts for the project and developing mitigation strategies to minimise risks. Risk assessment is undertaken in Section 8.0 and priority impacts and mitigation strategies are discussed in more detail in Section 9.0.

8.0 RISK ASSESSMENT PROCESS

A risk assessment process was undertaken to identify levels of risk and prioritise management needs. The risk assessment was undertaken in two parts.

The first part of the process, an initial risk assessment, was undertaken based on the available information, to identify a preliminary list of impacts. This formed the basis for the second part of the process, discussion at a risk assessment workshop of invited megafauna experts and project officers within regulatory agencies (refer Section 0 for list of attendees). The aim of the workshop was to identify a prioritised list of impacts and identify recommended mitigation strategies to minimise the likelihood or consequences of key impacts occurring.

The risk assessment details provided in this Section relate to the risk assessment agreed at the megafauna risk assessment workshop (refer Section 8.2).

8.1 RISK ASSESSMENT METHODOLOGY

The risk assessment methodology undertaken in this study is based on a modified version of the Australian/New Zealand Standard for risk management (AS/NZS 4360:2004; HB 203:2000). Modification was undertaken by Stocklosa (2001) as part of risk assessment methodology development for assessing impacts from coastal and marine activities as part of planning the South East Region Marine Plan for the National Oceans Office. Discussion of the process by Stocklosa (2001), which is largely replicated here, is undertaken with reference to the release of toxicants to the marine environment. The essence of the process remains relevant to the Shute Harbour Marina Development project however, even though impacts are more related to habitat disturbance rather than toxicant releases.

The risk management process is shown in Figure 8.1. Within this framework, risk managers must maintain focus on the practical aspects of conducting ecological risk assessment, which is often frustrated by a lack of scientific data or an insufficient understanding of environmental responses in natural systems. Seeking a balance between the use of natural resources and the preservation of environmental values is not an easy task. Generally, the problem is not in the technical management of risks arising from commercial hazards, but in the fact that the range of environmental values may not be well understood or agreed among government agencies, the public and special interest groups.

A balance must be sought to perform risk assessments in the most efficient manner. There is a need to control potentially prohibitive assessment costs and time, while ensuring that uncertainties are understood by decision makers without compromising the integrity of the results.

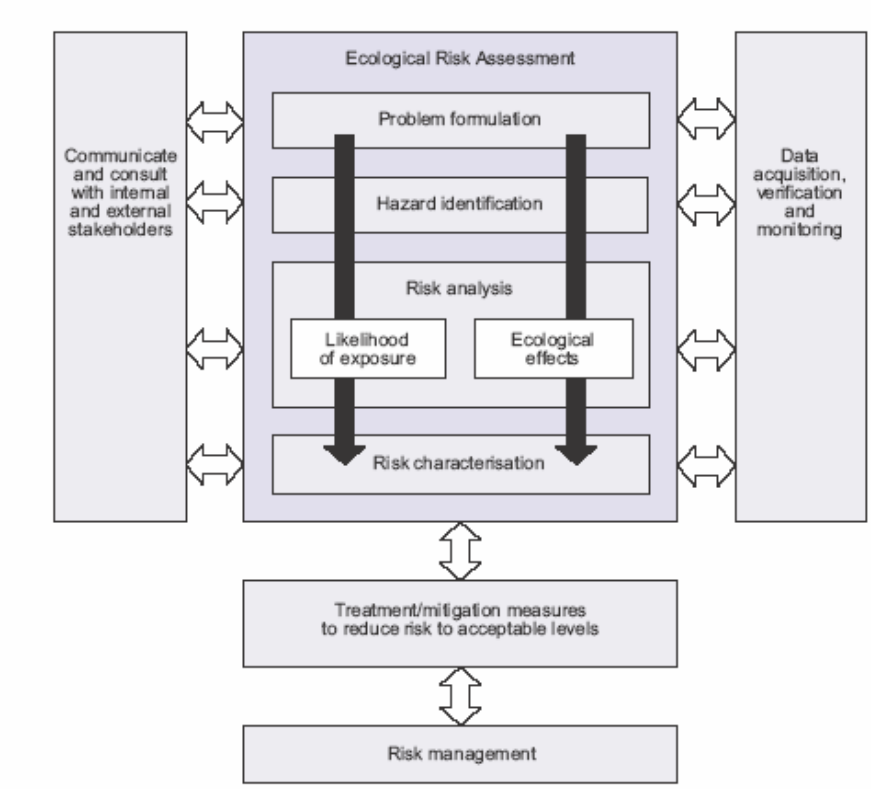

Figure 8.1 Framework for ecological risk management (Stocklosa 2001, after AS/NZS 4360)

8.1.1 Problem Formulation

The problem formulation step of the process establishes the context for the strategic and organisational conduct of the overall assessment. This begins with developing a shared understanding and appreciation of the area's unique and valued characteristics. A consultative approach with stakeholders is necessary to establish criteria for characterising the level of risk that might be associated with potential environmental impacts.

In the context of the Shute Harbour Marina Development, specialists on megafauna and their conservation, and stakeholders from relevant Government agencies have been consulted to develop this approach. This consultation was undertaken as a workshop exercise (19 December 2006) and individual discussion with megafauna experts within universities and government agencies.

Reviewing existing data is also essential within the problem formulation stage to determine the sensitivity of particular species, habitats or natural processes that are most vulnerable to potential environmental hazards. This has been undertaken in Sections 2.0 through 7.0 of this document.

8.1.2 Hazard Identification

Environmental hazards in the environment include both anthropogenic (refer Section 6.3) and natural hazards (refer Section 0) associated with the area of interest. In undertaking the risk assessment of potential impacts on megafauna from the development and operation of the Shute Harbour Marina Development, hazards considered include the list of potential impacts presented in Section 7.0. These impacts represent anthropogenic pressures on megafauna populations.

Many of these are not relevant to the Shute Harbour Marina Development, but must be raised to demonstrate that they have been considered.

From the identification of hazards, it is necessary to develop credible hazard scenarios for detailed risk assessment. Credible scenarios should be described in terms of circumstances where accidental or planned emissions to the environment are thought to be most likely to occur, and at locations where the most potential damage might eventuate. Credible hazard scenarios should represent realistic but severe situations for assessing risk.

It is not useful to assess 'worst case scenarios' for environmental risk assessment. This is because the responses of natural systems to perturbation may not be well understood, and the gaps in available data lead to some uncertainty in the estimation of risk. Further, the presentation of 'worst case scenarios' to decision makers suggests that the likelihood of an incident or emission and the severity of the consequences is known to produce the worst possible result, which is clearly not the case in environmental systems.

8.1.3 Risk Analysis

The methodology for risk analysis involves four technical disciplines, as shown in Figure 8.2 (Stocklosa, 2001). Primary and secondary exposure represents the physics and chemistry of a release of material or energy to the environment, while primary and secondary effects represent the organic response of the environment from exposure. Figure 8.2 illustrates how information developed at each step is used in a sequential risk analysis process.

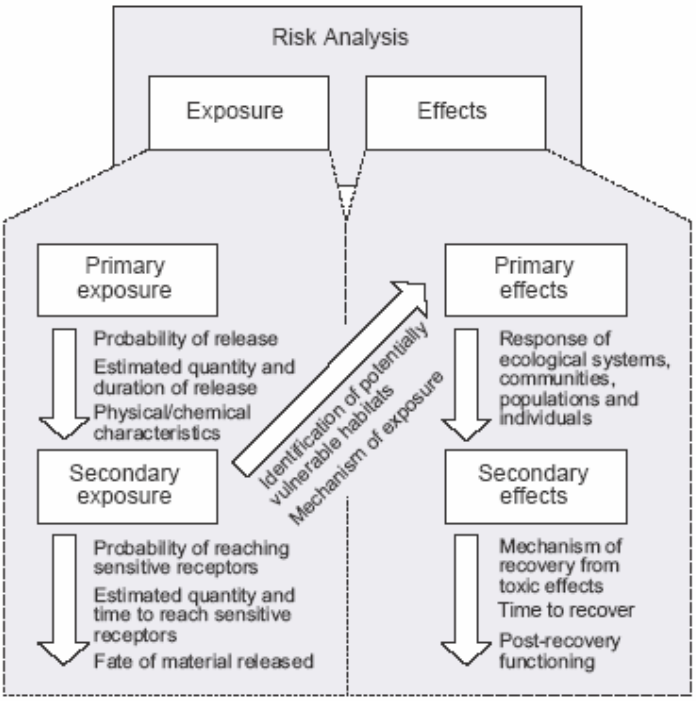

Figure 8.2 Steps in the ecological risk analysis methodology (after Stocklosa, 2001)

Primary and secondary exposure estimates can generally be estimated quantitatively from probabilities of release associated with the hazard scenario (e.g. increase in boating traffic), and the probability of the hazard coming in contact with sensitive receptors (e.g. dugong being in vicinity of boating traffic).

Primary and secondary effects estimates generally rely on a scientific but qualitative understanding of the mechanism of exposure and published observations of effects and recovery following exposure (e.g. dugong stopping feeding when boat passes within 50 m, followed by renewal of grazing activity).

The categories of likelihood of exposure were modified from Stocklosa (2001) and include categories from 'virtually impossible' to 'virtually certain', as shown in Table 8.1. These definitions were reviewed during the expert workshop and were found to be descriptively appropriate of potential exposure although it was considered that they could overemphasise likelihood, however this provides a level of conservatism in the risk assessment process.

Similarly, the severity of the effects is expressed in categories from 'negligible' to 'disastrous', as described by Stocklosa (2001), and shown in Table 8.2. These categories were reviewed by the expert workshop participants and found to be appropriate descriptors of potential effects.

TABLE 8.1 CATEGORIES OF LIKELIHOOD FOR CHARACTERISING RISK (MODIFIED FROM STOCKLOSA 2001, AFTER AS/NZS 4360)

CATEGORY OF LIKELIHOOD	PROBABILITY AND QUALITATIVE DESCRIPTION
Virtually Impossible	▪ This type of event has almost never occurred, but conceivably could.
Rare	▪ Such events have occurred on a worldwide basis but only a few times
Unlikely	▪ Event occurs, but it is not likely here within the project lifetime.
Likely	▪ Event likely to occur during the project lifetime.
Virtually Certain	▪ Event can be expected to occur more than once a year, including continuous emissions.

TABLE 8.2 CATEGORIES OF CONSEQUENCES (EFFECTS) FOR CHARACTERISING RISK (MODIFIED FROM STOCKLOSA 2001, AFTER AS/NZS 4360)

CATEGORY OF CONSEQUENCES	QUALITATIVE DESCRIPTION
Negligible	▪ Possible incidental impacts to flora and fauna in a locally affected environmental setting. No ecological consequences.
Minor	▪ Reduction of the abundance/biomass of flora and fauna in the affected environmental setting. No changes to biodiversity or the exposed ecological system.
Major	▪ Major environmental nuisance to the affected community. ▪ Reduction of abundance/biomass in the affected environmental setting. Limited impact to local biodiversity without a significant loss of pre-impact ecological functioning.
Severe	▪ Substantial reduction of abundance/biomass in the affected environmental setting. Significant impact to biodiversity and ecological functioning. Eventual recovery of ecological systems possible, but not necessarily to the same pre-impact conditions.
Disastrous	▪ Irreversible/irrecoverable changes to abundance/ biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-impact conditions.

8.1.4 Risk Characterisation

The results of the exposure and effects analysis can be used to characterise the level of risk for each of the credible scenarios being considered, in accordance with the classification strategy for exposure and effects described above. A matrix of the likelihood of occurrence (primary and secondary exposure) and severity of consequences (primary and secondary effects) is used to describe the relative level of risk for each hazard scenario in the context of existing (or proposed) measures to control the risk.

For the purpose of establishing the types of management actions that may be required to reduce risk to acceptable levels, the risk matrix is divided into four regions that represent four categories of overall risk, as illustrated in Figure 8.3. This type of approach represents the idealised model of how risks should be characterised for decision makers.

A preliminary risk analysis can be carried out so that similar risks are combined or low-impact risks are excluded from detailed study. Excluded risks should be listed to demonstrate the completeness of the risk analysis.

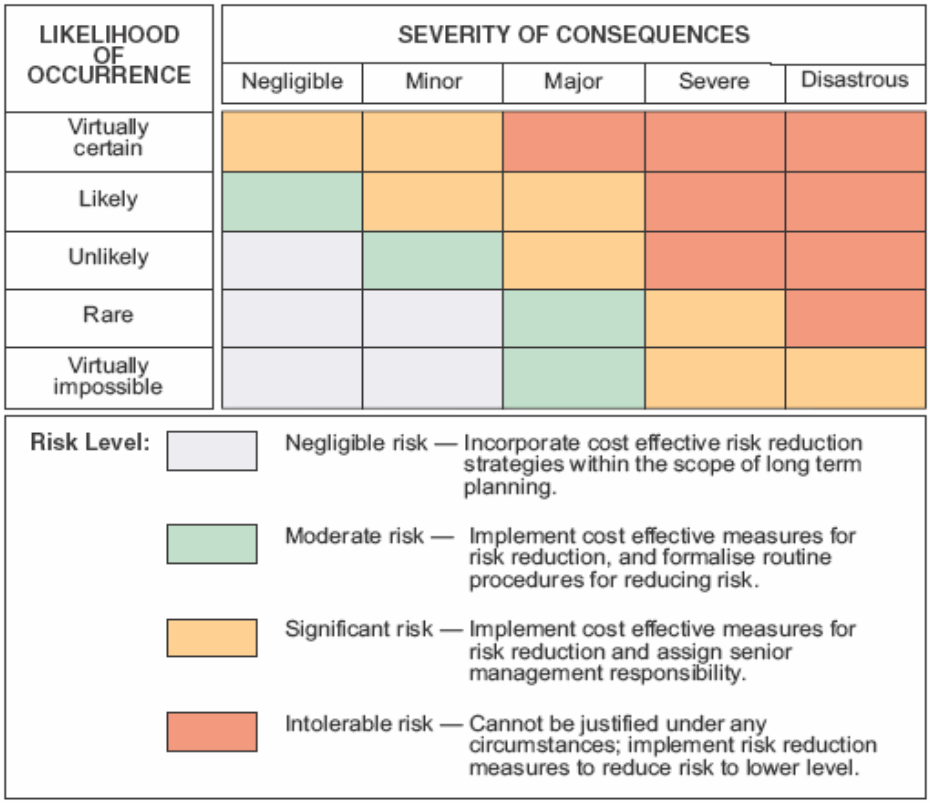

Figure 8.3 Matrix defining four possible regions of risk levels (taken from Stocklosa 2001, after AS/NZS 4360)

8.1.5 Risk Treatment and Management

The four levels of risk defined in Figure 8.3 each have a corresponding level of risk management objectives, based upon the principle of minimising risk to a level as low as reasonably practical (ALARP) (Wiig *et. al.*, 1996 in Stocklosa 2001). The principle of the ALARP approach is to treat, or reduce risks to the environment to an achievable level. Risk has been reduced to ALARP when further treatment measures become unreasonably disproportionate in cost and feasibility to the additional risk reduction obtained. The definitions in Figure 8.3 show that hazards that represent the highest level of risk

may be considered intolerable, not supportable on any grounds without mitigation measures that reduce the likelihood and severity of the risk to acceptable levels.

The ALARP management approach is recognition of the difficulty of establishing firm criteria for risk to ecological systems, where the natural variability of ecosystems and their ability to recover from exposure may be largely unknown. Consultation to establish assessment endpoints is used to aid decision makers with agreed criteria for judging risk.

8.2 SPECIALIST RISK ASSESSMENT WORKSHOP

A one-day specialist workshop was held at the office of Port Binnli Pty Ltd in Brisbane on 19 December 2006. Prior to the workshop, the background information and initial risk assessment outcomes were forwarded to participants as a paper for discussion. The framework for the conduct of the workshop was a risk assessment based on four key activities:

- Confirmation of the results of the background information collated;
- Review the initial risk assessment and agree on risk levels as a group;
- Prioritise the list of risks based on risk assessment outcomes; and
- Identify mitigation strategies necessary to minimise the likelihood or consequence of potential impacts occurring.

The following provides a list of contributors to the workshop, a discussion of the findings and general conclusions drawn from the workshop.

8.2.1 Workshop

The workshop was attended by megafauna scientists, regulators, project consultants and the proponent (Table 8.3). The workshop was facilitated by the EIS Project Manager, Michael Chessells from Cardno P/L.

TABLE 8.3 ATTENDEES AND APOLOGIES FOR EXPERT WORKSHOP

NAME	ORGANISATION
ATTENDEES	
Amanda Hodgson	Private Dugong Consultant
Kirstin Dobbs	Great Barrier Reef Marine Park Authority
Mark Read	Queensland Parks and Wildlife Service
Lyndell Davis	Department of the Environment and Heritage
Emma Hutchison	Department of the Environment and Heritage
James Ross	Office of the Coordinator-General
Kylie Keirs	Office of the Coordinator-General
Steven Fisher	Shute Harbour Marina Development P/L
David Quinlan	Shute Harbour Marina Development P/L
Robin Mudie	Shute Harbour Marina Development P/L
John Kennedy	Natural Solutions Environmental Consultants P/L
Cameron Slack	Natural Solutions Environmental Consultants P/L
Michael Chessells	Cardno P/L

NAME	ORGANISATION
Erin Young	Cardno P/L
John Thorogood	FRC Environmental P/L
APOLOGIES	
Colin Limpus	Environmental Protection Agency
Steve Elson	Environmental Protection Agency

8.2.2 Workshop Outcomes

The following points summarise the outcomes of the workshop:

- Megafauna experts provided recently published, unpublished and in-press information regarding marine mammals, which has been incorporated into species profiles in this document (refer Section 5.0).
- Workshop participants considered that a risk assessment approach to assessing impacts to marine megafauna and prioritising management measures based on the risk level was an appropriate method.
- The initial risk assessment that provided a discussion base for the workshop received only minor modification, resulting in a few hazard scenarios being elevated from *moderate* to *significant* risk level.
- Several additional potential impacts/hazard scenarios were developed and tested. These have been included in the risk assessment section (Section 0).
- Participants requested further opportunity to review mitigation strategies and provide comment. This opportunity was provided following update of the document after the workshop.

8.3 RISK ASSESSMENT

In line with the risk assessment protocols identified in Section 8.1, the potential human-related impacts identified in Section 7.0 were given a risk priority based on the likelihood of the issues to have a detrimental effect on megafauna of the area. The risks assessment resulting from the megafauna risk assessment workshop is presented in tabular form in Table 8.4. Priority impacts resulting from this risk assessment and their mitigation strategies are discussed in more detail in Section 9.0.

TABLE 8.4 RISK ASSESSMENT TABLE

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Artificial lighting	Lighting disrupts critical behaviours of adult female nesting turtles and hatchlings, such as nest selection and sea-finding behaviour.	Unlikely No nesting beaches in the vicinity of the project site.	Minor Limited disorientation of adult/hatchling turtles in vicinity of marina development.	Moderate
Water quality degradation (stormwater)	Inflow of stormwater containing elevated levels of sediments, nutrients, oils and metals enters Shute Bay and reduces water quality, impacts benthic ecology and megafauna presence within project vicinity.	Unlikely Water quality degradation is primarily due to agricultural and urban sources. The catchment area of Shute Bay and the marina development is very small. Stormwater from marina will undergo treatment prior to release into marina.	Minor Potential cumulative impact due to increasing development in region, but inshore water quality is naturally turbid and subject to oil and metal loads from the adjacent roadway.	Moderate
Water quality degradation (sewage)	Accidental (or intentional) release of sewage from boats, or faeces from dogs on boardwalk, degrades water quality and reduces megafauna presence in Shute Bay.	Virtually certain Marina will provide sullage pump-out facilities to limit nutrient input. The keeping of cats and dogs is to be prohibited in the marina and residential development. Dogs and cats will only be permitted in public access areas if they are on lead. Owners will be required to pick up droppings. SHMD will provide collection bags and disposal stations to facilitate this. However, Accidental (or intentional) release would be expected at least once a year despite provision of facilities, education and regulation to minimise potential for release.	Negligible Infrequent minor release of raw sewage won't cause water quality degradation within Shute Bay.	Significant

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Habitat loss	Loss of seagrass and soft-bottom habitat from construction of the land development, marina basin and entrance channel reduces populations of Dugong and/or herbivorous/omnivorous turtles in Whitsunday region.	Likely Construction will result in the disturbance of about 35 ha of intertidal and subtidal habitat, including the loss of about 14 ha of sparse seagrass from within the marina footprint and entrance channel (FRC Environmental, 2008). Dredge plumes may impact on small patches of sparse and moderately dense seagrass (*Halodule uninervis*) communities (3.12 and 1.06 ha respectively) (FRC Environmental, 2008). Hydrodynamic changes are not anticipated to result in significant net loss or gain of seagrass habitat within Shute Bay (FRC Environmental, 2008). Dugong are not known to use the Shute Bay project area and the area appears not to represent significant habitat. Turtles, particularly Green Turtles, have been observed in Shute Bay, but their occurrence is infrequent.	Minor Less that 0.1% of unvegetated soft bottom habitat of region will be lost, resulting in minor local impact only. About 10% of the seagrass in Shute Bay would be lost, which is about 0.3% of seagrass meadows in the Whitsunday coastal region and about 0.15% of the total Whitsunday region (Campbell, 2002). Loss of habitat in an area that is infrequently utilised by megafauna represents minor potential consequence.	Significant

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Food source loss (local)	Total and permanent loss of patchy, sparse (<5% cover) seagrass (*Halophila ovalis* and *Halodule uninervis*) within construction footprint reduces populations of Dugong and/or herbivorous/omnivorous turtles in Whitsunday region.	Likely Construction will result in loss of about 8 ha of patchy, sparse (<0.5% cover average, with small patches up to 5% cover) seagrass from the Shute Bay project area. Dugong are not known to use the Shute Bay area and the area appears not to represent significant habitat. No Dugong feeding trails have been recorded. Turtles, particularly Green Turtles, have been observed in Shute Bay, but their occurrence appears infrequent. These turtles may feed on the seagrass within the bay, potentially from less sparse patches.	Minor Seagrasses in construction footprint are sparse, while there are moderately dense meadows in adjacent areas in the bay and the Whitsunday region. Area is not frequented by dugong and infrequently used by Green Turtles. Loss of sparse food resources that are not well utilised by megafauna represents minor potential consequence.	Significant
Food source loss (local)	Loss of remainder of sparse seagrasses outside project footprint in Shute Bay, from either direct or indirect impacts, reduces populations of dugong and/or herbivorous/omnivorous turtles in Whitsunday region.	Unlikely Water quality objectives are to be met prior to release of dredging return waters to protect seagrasses and adjacent corals from effects of significantly elevated turbidity levels. Monitoring program to include seagrass and water quality monitoring.	Minor Modelling, mitigation techniques and monitoring programs will be designed and implemented to protect seagrasses and coral communities from significant impacts. Area is not frequented by dugong and is infrequently used by Green Turtles. Loss of sparse food resources that are not well utilised by megafauna represents minor potential consequence.	Moderate

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Food source loss (local invertebrates)	Loss of soft-bottom invertebrate foods from within the project footprint reduces omnivorous/carnivorous turtle species populations within Whitsunday region.	Virtually Certain Loss of benthic invertebrate food sources in construction footprint during marina construction. Maintenance dredging activities may regularly remove recovering communities within harbour and entrance channel sediments.	Negligible Loss of invertebrates from construction footprint may be partially offset by invertebrates living on marine structures associated with the marina. Reef nearby provides far better feeding opportunities for omnivorous/carnivorous turtles.	Significant
Four wheel driving on turtle nesting beaches	Destruction of turtle nesting habitat by four wheel drive vehicles on nesting beaches.	Virtually impossible No four wheel drive access to beach.	Negligible No turtle nesting beaches at project site or in vicinity.	Negligible

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Coastal development	Cumulative coastal development from Shute Harbour marina development is incompatible with megafauna function within the Whitsunday region.	Rare Extreme coastal development may present a significant issue (e.g. some Asian coastal cities such as Hong Kong and Singapore), but even large coastal Australian urban centres can co-exist with megafauna (e.g. Brisbane within Moreton Bay catchment), although some decline in population has occurred. Extreme development, or even large urban centre development will not occur at Shute Harbour due to local government planning restrictions and adjacent National Park areas limiting development expansion.	Major Unconstrained coastal development could have significant impact on megafauna through pollution, habitat and food source loss. However, the scale of development in the Shute Harbour region is highly unlikely to represent a major threat, provided significant food resources in the Whitsunday region are protected through continued protection of marine plants and other habitats through legislation and regulation of pollution management.	Moderate
Beach armouring	Beach armouring destroys turtle nesting habitat.	Virtually impossible No turtle nesting beaches at project site. Beach area will be reclaimed within the project development footprint.	Negligible No turtle nesting beaches at project site or in vicinity.	Negligible
Beach nourishment	Beach nourishment smothers turtle nesting areas.	Virtually impossible No beach to be renourished.	Negligible No turtle nesting beaches at project site or in vicinity.	Negligible
Sand mining	Sand mining destroys turtle nesting habitat.	Virtually impossible No sand mining proposed on project site. Offsite sand for fill is from licensed supplier.	Negligible No sand mining to be undertaken on project site.	Negligible

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Marine construction	Months of marina construction result in megafauna avoiding the Shute Bay area.	Likely Development will be constructed in the marine environment. This is a temporary event, so impacts are temporary, not persistent.	Negligible Area is not frequented by dugong and infrequently used by Green Turtles. Any megafauna that might consider using the area would temporarily leave the vicinity due to activity and construction noise. Megafauna may return to area after construction ceases, although this depends on the level of operational activity.	Moderate
Boat strike	Increasing boating traffic results in significant increase in boat strikes on megafauna (primarily to turtles and dugong).	Likely Regional issue with increasing boating traffic generally. Marina may encourage more boat operators to visit region due to improved services provision. Juvenile Green turtles may come into marina to feed on algae growth.	Major Significant increase in boat strike numbers may result in population decline for turtles and dugong. Cetaceans are less likely to be hit, and killed, by boats due to their size (whales) and greater mobility (dolphins) than turtles and dugongs. This is based on fewer deaths attributed to boat strike on cetaceans compared to turtles and dugongs in the EPA mortality database for marine strandings.	Significant

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Boat disturbance	Increase in boating traffic in Whitsunday region interrupts normal behaviour.	Virtually Certain Expected that boating traffic passing nearby megafauna may influence behavioural activity.	Negligible Wider Whitsunday context: Animals may move off momentarily if disturbed. Shute Harbour Marina Development context: Continued disturbance in the area of Shute Bay may result in permanent avoidance of the bay. However, Shute Bay does not contain critical habitat for species likely to utilise the bay. Other areas in Whitsunday region appear to contain more preferred habitat.	Significant
Dredging	Dredging results in injury or death to turtles. Cetaceans generally at lower risk of dredging impacts. (Indirect impacts of dredging through habitat loss is assessed elsewhere in this table)	Rare Dredging is likely to occur only every 7 to 10 years under normal circumstances. Dredging activities will be undertaken using cutter-suction and bucket dredges. These dredges are small and move slowly. Turtles would avoid cutter head and would rarely, if ever, be impacted.	Major Cutter head could severely injure or kill megafauna if fauna came too close to cutter head. Loss of individual unlikely to result in population decline.	Moderate

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Underwater explosions	Underwater explosions will not be used as a construction method. Area is not a Defence facility.	Virtually impossible Explosive construction methods not used as construction method.	Negligible Construction will not involve underwater explosions.	Negligible
Oil spill (infrequent major)	Accidental large release of fuel (e.g. from refuelling line rupture or vessel sinking) causes direct or indirect impact (e.g. poisoning food sources) to megafauna.	Likely Oil spill is likely to be contained within marina and extent will be limited by use of oil containment and recovery equipment. Oil is lighter than water so remains on water surface, so unlikely to poison potential food sources of megafauna.	Major Megafauna within the marina at the time of release may suffer health effects or irritations. Megafauna outside containment area are very unlikely to be significantly affected by any residual fuel following completion of containment and recovery operation.	Significant
Oil spills (frequent minor)	Frequent minor release of fuel during refuelling activities causes direct or indirect impact (e.g. poisoning food sources) to megafauna.	Virtually Certain Dripping of fuel oils is common in marinas. Numerous management measures limit the potential for fuel to enter water during refuelling, but dripping may still occur more frequently than once per year.	Minor Fuel oils are not likely to be of such a level to cause health effects, but may cause irritation if megafauna were to come into direct contact. Small releases can appear large in water due to visible film.	Significant

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Marine debris (through entanglement and ingestion)	Increase in debris load from marina results in turtles, cetaceans or dugong becoming injured or killed through entanglement or ingestion	Likely Waste at marina will be managed through provision of bins and litter collection program. Litter from stormwater will be minimised through use of gross pollutant traps. Accidental release of debris is a possibility within life of project though.	Major Accidental, minor release of debris may result in injury or mortality of individuals through ingestion or entanglement.	Significant
Chemical pollution	Accidental release of chemicals (e.g. boat paint/varnish) into water through spillage causes sickness or death to megafauna.	Certain It is possible that boat owners may accidentally spill chemicals, such as paints/varnishes, to the marina waters while undertaking minor maintenance on boats. Note, no dedicated boat maintenance facilities are proposed in marina development.	Negligible Any spillage is likely to be minor in extent and unlikely to impact significantly on modified habitat of marina. Maintenance of boats will not be permitted in the marina.	Significant
Fisheries and incidental capture	Presence of marina development indirectly promotes increased fisheries pressure resulting in increase in incidental capture.	Virtually Impossible Marina will not cater to commercial fishing vessels (although charter fishing vessels will be permitted to berth). No fishing of any sort will be permitted within the marina.	Negligible Increase in fishing pressure and potential for incidental capture would be negligible as a result of the marina development as marina will not cater to commercial fishing vessels. Additionally, fishing regulation is outside jurisdiction of marina developers and managers.	Negligible

POTENTIAL IMPACT OF PROJECT	HAZARD SCENARIO	LIKELIHOOD	CONSEQUENCE	RISK
Indigenous hunting	Marina users undertake indigenous hunting.	Virtually impossible Marina operators/developers will not undertake indigenous hunting.	Negligible Indigenous hunting will not be undertaken, except by Traditional Owners. Not a responsibility of marina developers or operators.	Negligible
Direct take of adults and turtle eggs by 'poachers'	Persons intentionally take turtle individuals or eggs from nesting beaches.	Virtually impossible No turtle nesting beaches in vicinity and therefore no eggs. Taking of turtles or eggs is regulated under legislation. High number of persons present at marina likely to deter poachers.	Negligible No turtle nesting beaches in project vicinity.	Negligible
Predation by domestic and feral animals.	Adult and hatchling turtles being predated by feral or domestic animals on nesting beach.	Virtually impossible No turtle nesting beaches in the vicinity of the project site.	Negligible No turtle nesting beaches in the vicinity of the project site.	Negligible

Table 8.5 summarises the potential impacts within the four risk categories. There were no Intolerable risks identified, eight Significant risks, six Moderate risks, and eleven Negligible risks.

Potential impacts listed as negligible are not considered further in this megafauna management plan, as they are either not relevant to the site or their inherent risks or mitigated risks are acceptably low.

TABLE 8.5 PRIORITISED RISK ASSESSMENT SUMMARY TABLE

RISK CATEGORY	POTENTIAL IMPACT OF CATEGORY
Intolerable	No impacts categorised as Intolerable
Significant	Boat strike Boat disturbance Habitat loss Food source loss (within project site) Oil spills (infrequent major spill) Oil spill (frequent but minor spills) Marine debris Water quality degradation (sewage)
Moderate	Coastal development Marine construction Dredging Food source loss (outside project site) Artificial lighting Water quality degradation (sediments)
Negligible	Four wheel drive access Beach armouring Sand mining Beach nourishment Underwater explosions Chemical spills Fisheries and incidental capture Indigenous hunting Direct take of adults and turtle eggs Predation by domestic and feral animals

9.0 PRIORITY IMPACTS AND MITIGATION STRATEGIES

This Section explores further the risks that were identified as being Significant and Moderate in the risk assessment process. These are the risks that have the greatest potential to threaten marine megafauna as a result of the Shute Harbour Marina Development. The site context and specific mitigation strategies for each impact are discussed. Specific mitigation recommendations, including responsible parties and reporting requirements, are presented in Section 10.0. Mitigation measures relevant to construction would be detailed in a Construction Environmental Management Plan for Operational Works approval. Operational mitigation measures would be included in a Marina Management Plan in support of the development approval application for ERA 73 for the operation of a marina.

9.1 BOAT STRIKE

9.1.1 Risk Assessment Rating

Significant risk = Likely likelihood x Major consequence

9.1.2 Impact

Boating is an activity that is increasing in popularity especially in areas of population expansion adjacent to coastal districts. One in 22 people in Queensland own a boat and the number is rising by 5% a year, which is higher than the Queensland population growth rate (Premiers Office, 2006). This increase in boating activities leads to greater conflict between human activities and many marine wildlife species. As a result of this conflict, there has been an increase in the number of recorded propeller or other boat strikes on marine wildlife, which can kill or seriously injure these species (GBRMPA, undated G).

Because of their physical size and distribution in coastal waters, marine megafauna are susceptible to boat strike. In Queensland in 2005, one dugong death was caused by boat strike, one was rescued after being hit by a boat and there were another 2 unidentified incidents. Over the last 10 years the average number of dugong killed in Queensland by boat strike is 3 per year with further unidentified incidents recorded (Greenland and Limpus, 2006). For cetaceans in 2005, boat strike attributed to the deaths of 2 unidentified species of dolphin, with an average of 1 cetacean killed each year for the last 10 years (Greenland and Limpus, 2006a).

Dugongs have been shown to be at great risk of boat strike given their reactions to approaching vessels (Maitland *et. al.*, In Press). It has been found that dugong reactions to approaching vessels are related to the distance to the boat rather than its speed (Hodgson, 2004). This means that often dugong fail to respond fast enough to approaching vessels and hence are struck. It was also found that in some cases the dugong did not react until the boat was overhead or had already passed.

Boat strike is not the only impact that boats can have on marine fauna populations. The presence of boats may also affect the behaviour of some of these animals (see Section 0 for discussion of boating disturbance).

9.1.3 Site Context

The Shute Harbour Marina Development will provide part of the regional infrastructure necessary to service the boating industry of the Whitsunday region. The marina will provide mooring facilities for up to 669 vessels up to 35 m length.

In itself, the marina may not necessarily cause boating numbers in the region to increase, as they are expected to increase over time as boat usage in the region increases (i.e. boats will not head to the region just because there is a new marina). It will however, significantly increase the boating traffic locally, within and around Shute Bay, particularly during holiday seasons, as boats access the marina (Thompson Clarke, 2008).

It is understood that a regional approach to managing increasing boating traffic in the Whitsunday area is being developed by the Department of State Development. Shute Harbour Marina Development will contribute to the development of this plan as a key stakeholder in the region. A key outcome of this regional approach will be methods to manage the potential for boat strike on a regional basis.

9.1.4 Mitigation Strategies

Increasing numbers of boats in the region means that effective management plans are needed to ensure the safety of marine mega fauna.

Many studies recommend controls on vessel speed to help reduce the impact of boating activities on marine mega fauna populations (Groom & Lawler, In prep; Marsh *et. al.*, In Review; Ng & Leung, 2003). While it has been accepted that slower moving boats are less likely to come into contact with fauna there is an issue with compliance and policing of "go slow" areas (Groom *et. al.*, 2004; Maitland *et. al.*, In press).

Another method of avoiding boat strike or disturbance from boat movements is the use of "Vessel Transit Lanes" (Groom & Lawler, In prep). The idea of "Vessel Transit Lanes" is to move significant boat movements away from areas where there may be concentrations of animals, for example, shallow seagrass areas that are important feeding habitats for dugong and turtles.

It should be noted from the marine traffic study (Thompson Clarke, 2008 Appendix K2 of the EIS) that traffic will be encouraged to leave the marina by deeper access channels. It would therefore be logical to assume that the vessels on swing mooring in the shallower part of the bay present a greater risk to mega fauna. Without a marina at Shute Bay, the number of vessels on swing moorings which current stands at approximately 300 would continue to increase.

Groom and Lawler (In prep.) investigated the efficiency of the "go slow" and "Vessel Transit Lanes" in Missionary Bay, Hinchinbrook Island. The results of this investigation showed that the zones were ineffective in reducing boat strike due to low compliance levels and the inappropriate location of the "Vessel Transit Lanes". Groom and Lawler (In prep.) state that restricting boat speed and distributions are the only feasible way to reduce boat risk to marine fauna and that careful consideration into the location of "go slow" and "Vessel Transit Lanes" is vital for both optimal compliance by the public and efficiency in avoiding high impact areas (such as feeding grounds and migration routes). Such considerations will be central to managing boating traffic in the Whitsunday region as a whole. Shute Harbour Marina Developments commits to implementing boating management strategies that are within its control as a marina operator.

It should be noted that, the Schedule of Speed Limits in Queensland (Maritime Safety Queensland, 2008) stipulates that the waters of Shute Harbour (including Shute Bay) have a declared speed limit of 6 knots for vessels of all sizes (Figure 9.1). Further, all boat harbours and marinas in Queensland also have a 6 knot speed limit under the Schedule. Enforcement of the speed limit within the declared area will limit the potential for all megafauna to be struck boat within Shute Harbour waters.

While SHMD marina operators do not have the jurisdictional powers to issue fines for speeding, they will "enforce" the speed limit through a "three strikes" policy. Under this policy, vessels observed breaking the speed limit on three occasions will have their berthing privilege removed and they will be asked to leave the marina. Visual monitoring will entail opportunistic visual survey (and possibly photography) for boats at planning speed, which is when the risk of boat strike is greatest. Vessel owners and operators will be reminded of the speed limit upon each observed breach and a register will be kept of breach particulars and offending vessel details.

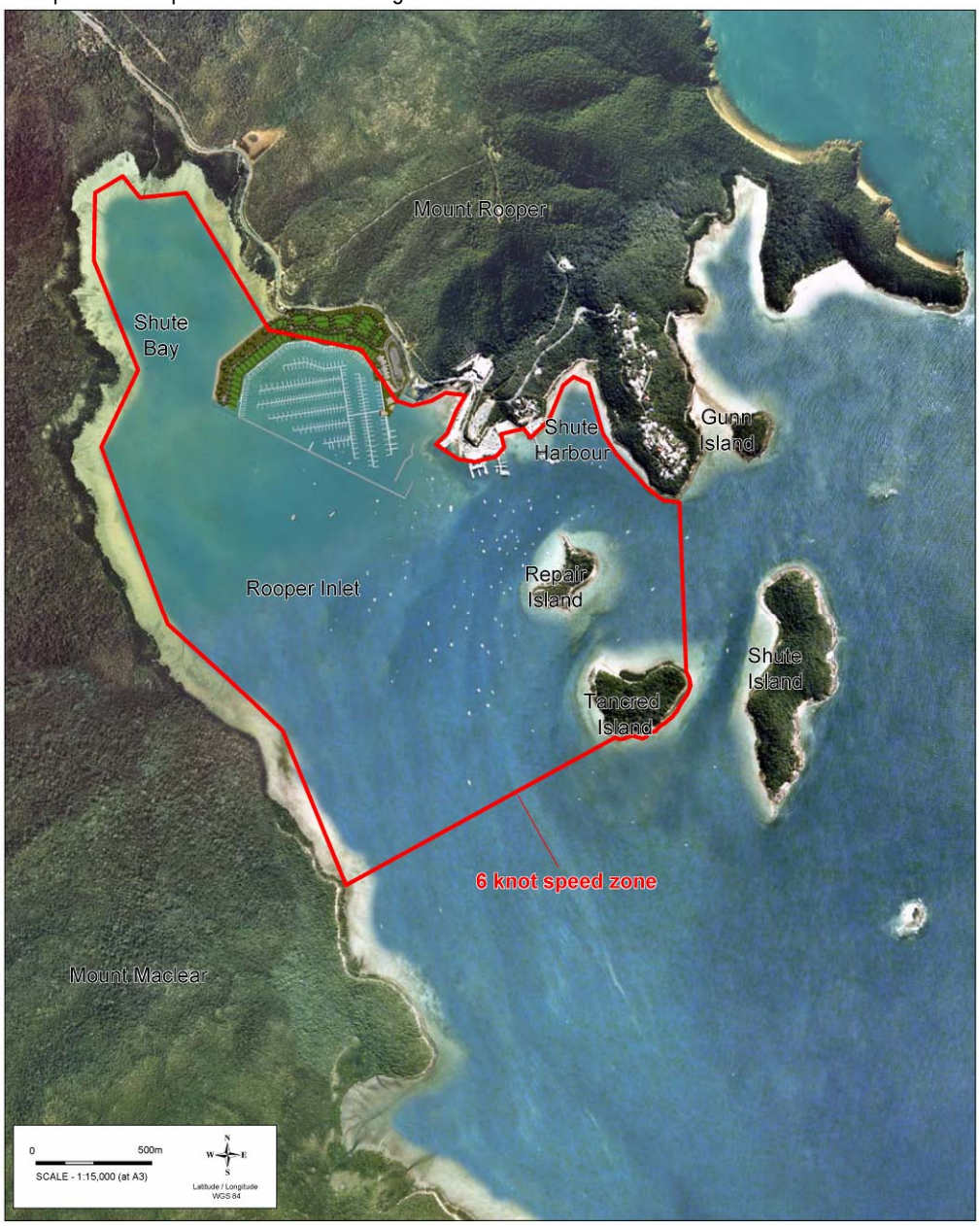

Figure 9.1 Declared 6 knot speed zone within Shute Harbour waters as outlined by Maritime Safety Queensland (2008).

In addition, SHMD will promote best practice environmental management measures for boating to users of the marina. The Great Barrier Reef Marine Park Authority has currently identified best practice environmental management with regard to boating, including actions to reduce boat strike. General boating best practice includes:

Be on the look out for marine animals and travel slowly in areas where they are known to be present. For example:

- Humpback whales migrate along the Reef from May to September;
- Dugongs inhabit shallow seagrass areas;
- seabirds nest or roost on sand cays and islands; and
- marine turtles are commonly found in shallow reef and seagrass areas - especially during September and October when mating behaviour brings them close to the surface.
- Look out for shallow coral, or other environmental hazards, and take into account tidal changes. Leave at least 30 centimetres clearance between the propeller and seabed;
- Slow down to minimise the wake when approaching reef edges, shorelines and beaches;
- Check for nesting seabirds or turtles before pulling vessels up onto beaches;
- Avoid pulling boats up onto delicate beach vegetation such as sand dunes;
- Take all litter (for example, rubbish, food scraps and cigarette butts) with you and responsibly dispose of it on shore;
- Collect litter that you find on and in the water, and ashore;
- Be considerate of others when motoring or anchoring near them (for example avoid wakes and do not anchor too close);
- Keep noise levels low to minimise animal disturbance;
- Use four stroke engines, whenever possible; and
- Immediately report any injured or dead marine turtles or mammals to the EPA Hotline on 1300 130 372 (24 hr) (GBRMPA, undated H).

Signage of general boating best practice will be erected in the boat harbour and provided for the public boat ramp. An information brochure will also be included to applicants for berthing at the marina. Part of the proposal is for a marine interpretive centre as part of the marina office building. EPA and GBRMPA will also be invited to give educational presentations at the centre, where best practice boating can be further promoted. SHMD will also regularly emphasise best practice in monthly newsletters to harbour users.

Design measures to reduce the likelihood of boat strike will also be considered, particularly in entrance channel areas where turtles might rest on the bed. One of these recently identified by Colin Limpus (EPA, pers. comm.) is modification to dredging design, whereby overdredging is undertaken outside the navigation channel area to provide small coves where turtles may rest while remaining outside the main navigation channel and away from boating traffic. This design would need to consider erosion and accretion levels within the bay as scouring through channelisation of water flows should be avoided. Another potential method is to vertically overdredge the sides of the channel to provide for depressions for turtles to rest at the channel edges and therefore less likely to be struck by boats using the central part of the channel. These design considerations have been included in the entrance channel design.

9.2 BOATING DISTURBANCE

9.2.1 Risk Assessment Rating

Significant risk = Virtually Certain likelihood x Negligible consequence

9.2.2 Impact

Boating traffic has the potential to both disturb and displace marine mammals (Richardson *et. al.*, 1985; cited in Hodgson & Marsh, 2007). Disturbance occurs when marine mammals respond to noise or perceived risk to boat strikes. Persistent interruptions of important behaviours such as feeding, courtship and mating can be energetically costly and affect the reproductive success of individuals. If, together with the direct risk of boat strike, disturbance from boats costs marine

mammals more than the benefits of the resources available in an area, populations may be displaced. Both the reduction of habitat availability and the costs of disturbance can affect the survival of individual marine mammals and therefore entire populations (Hodgson & Marsh, 2007).

There is a relatively large amount of literature on the behavioural responses of cetaceans to boats. Short-term responses include: changes in swim direction, increased swim speed, shortened surface times, lengthened interbreath intervals, reductions in inter-individual distances, changes in the types of surface behaviours exhibited, reductions in resting behaviour, an increase in breathing synchronicity between individuals and increased rates of whistle production (Hodgson & Marsh, 2007).

In general, marine mammals tend to be most tolerant of boats moving at a consistent speed and least tolerant of fast, erratically moving boats (Richardson *et. al.*, 1985; cited in Hodgson & Marsh, 2007). Responses of some cetaceans increase as the level of boat traffic increases and the distance of the passing boat decreases.

Long term effect of boat traffic includes displacement and occupation of deeper waters rather than shallower waters where food resources might be.

Hodgson & Marsh (2007) assessed the risk of disturbance and displacement of dugongs from boat traffic in Moreton Bay, southern Queensland. They found that individuals were less likely to continue feeding if a boat passed within 50 m. Generally, mass movement of herds of dugong reacting to boats passing within 50 m lasted only 122 seconds. The levels of boat traffic observed in Moreton Bay were estimated to reduce dugong's feeding time budget by a maximum of 0.8 – 6%, so it was considered that boating activity was unlikely to have a substantive effect on the energy intake of dugongs in Moreton Bay because of significant seagrass beds. The situation may be different in areas with patchy seagrass beds, with potential for increased impacts on dugongs.

9.2.3 Site Context

The Shute Harbour Marina Development will provide part of the regional infrastructure necessary to service the boating industry of the Whitsunday region. The marina will provide mooring facilities for up to 669 vessels up to 35m length.

An increase in boating traffic in the Whitsunday area will result in more frequent interactions between boating traffic and megafauna. The potential for disturbance and displacement to marine megafauna, particularly marine mammals, will depend on the level of boat traffic and the distance of the passing boat.

The increase in boating traffic in the region is largely inevitable as urbanisation and tourism pressures increase in the Whitsunday area. The potential for disturbance and displacement to occur will relate to the extent to which distances between boats and marine mammals are managed.

The immediate area of the marina development in Shute Bay does not represent preferred habitat for marine mammals, so distances between boats and marine mammals is likely to remain adequate to minimise boating disturbance risk. The potential for boating disturbance and displacement will be more relevant at a regional scale and requires a regional approach to manage potential impacts.

9.2.4 Mitigation Strategies

Mitigation strategies for boating disturbance have commonality with those for boat strike (refer Section 0). This includes: involvement in a regional approach to managing increasing boating traffic in the Whitsunday area, enforcement of speed zones and education of boating operators regarding general boating best management practices.

In addition to signage regarding general boating best management practices, further information will also be available to boat operators specifically relating to best practice relating to dugongs, which appear to be at greatest risk of boating disturbance. This information would be available with other educational materials in the marina office (or other educational area) and be emphasised on occasion in the environment section of the monthly newsletter. Best practices to be emphasised include:

- Do not chase, harass, take, catch or kill dugongs;
- In shallow seagrass areas keep a lookout for dugong and go slow e.g. less than 10 knots;
- Do not approach a dugong closer than 50 metres;
- If you happen to be within 50 metres of a dugong, avoid where possible engaging the propeller and move off slowly at less than planning speed;
- Do not swim, dive or enter the water near a dugong;
- Do not feed, touch or interfere with a dugong, for instance by loud noise or sudden movements; and
- Avoid separating a female dugong from her calf (GBRMP, undated I).

9.3 MARINE DEBRIS

9.3.1 Risk Assessment Rating

Significant risk = Likely likelihood x Minor consequence

9.3.2 Impact

Marine debris (pollution of the marine environment by human generated objects) can be harmful to marine wildlife through ingestion and entanglement (Threatened Species Scientific Committee, 2003). Listing of 'Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris' as a key threatening process under the EPBC Act demonstrates the Department of the Environment and Heritage's recognition of the risks associated with marine debris.

The disposal of plastics anywhere in the world into the sea is prohibited under the *International Convention for the Prevention of Pollution from Ships* (known as MARPOL 73/78). MARPOL 73/78 also prohibits the disposal of all other types of garbage within 12 nautical miles of the outer reef. The law provides for fines of up to $1.2 million for companies and $220 000 for individuals illegally discharging garbage at sea.

9.3.3 Site Context

Shute Bay is currently exposed to anthropogenic debris from both terrestrial and aquatic systems. Debris items currently found along the shoreline in the vicinity of the project site include plastic bags and containers. There is a considerable debris load in the bay adjacent to the project site, with debris items including logs, metal sheeting, rock debris and derelict boats and barges (refer Figure 9.2).

Figure 9.2 Debris load along shoreline in vicinity of the project.

While the construction of the marina development would result in the removal of existing debris loads within the development area in Shute Bay, the operating marina could potentially be a source of debris in the local vicinity without appropriate controls in place. Items of debris could include a range of rubbish including plastic bags, containers and food wastes. This would harm not only the marine environment but also significantly reduce the aesthetic appeal of the marina and shoreline development. A range of strategies will be employed to reduce the potential for debris to occur within the marina precinct.

9.3.4 Mitigation Strategies

The Shute Harbour area is serviced by a waste contractor for collection of domestic and commercial wastes on behalf of the Whitsunday Shire Council (WSC). Commercial waste collection agreements will be negotiated with WSC and the waste contractor.

Bins for rubbish collection and recycling will be placed at strategic places around the harbour precinct so that charter boat operators, boat owners and visitors will have appropriate places to dispose of rubbish and recyclable materials. Signage will be placed around the precinct stating that it is an offence to litter. Inevitably though, some litter will occur, so additional control measures are proposed in the way of regular monitoring and rubbish removal.

The provision of recycling facilities at the marina will assist charter boat operators within the Great Barrier Reef Marine Park to achieve certification under the ECO Certification Program operated by Ecotourism Australia, provided a wider range of criteria are also met by the operator. Certification will enable the charter operator to obtain 15 year permits for operation within the Great Barrier Reef Marine Park, rather than the standard 6 year permit.

Additional control of direct impacts from litter will be achieved through the implementation of a litter collection program (targeting only anthropogenic items) within the marina development. A visual assessment of litter levels will be conducted weekly to determine whether litter collection activities are required. If during the visual inspection there are significant litter levels noted, litter collection will be organised by the marina managers. Regularity of litter collection will be re-assessed after the first twelve-months to determine whether collection activities are sufficient. As part of best management practice

for environmental management for marinas, management of organic rubbish will be particularly important in limiting the attraction of the marina to crocodiles.

Gross pollutant traps will be installed in stormwater drains to limit the potential for litter to enter waterways with stormwater flows.

9.4 ARTIFICIAL LIGHTING

9.4.1 Risk Assessment Rating

Moderate Risk = Unlikely likelihood x Minor consequence

9.4.2 Impact

Artificial light is most detrimental to turtles, particularly adult female nesting turtles and hatchlings through the disruption of critical behaviours such as nest selection and sea-finding behaviour (Lutcavage, *et. al*., 1997). Long-term light pollution may lead to the reduction of suitable available nesting habitat and may force turtles to utilise less appropriate nesting sites. Dr Colin Limpus (Environmental Protection Agency) asserts that lighting impacts on sea turtles is the most critical management issue of relevance to coastal development within Queensland (C. Limpus, pers. comm. in C&B Group, 2005).

Hatchlings emerge from their nests generally in the early evening and use visual cues to locate the sea (similar process used by nesting female turtles). This sea-finding process is achieved by identifying the brightest location closest to the horizon within a 180 degree "cone of acceptance", which is generally the sea on an undeveloped beach (Salmon, 2003a; Salmon, 2003b). When coastal developments are located too close to turtle nesting beaches, with no consideration for light management, nesting adults and hatchlings often become disoriented and move towards artificial light sources and may eventually succumb to exhaustion, dehydration and predation (Lutcavage et. al. 1997).

9.4.3 Site Context

There are no sandy beaches within the vicinity of Shute Bay that are considered to be good turtle nesting beaches (QPWS, pers. comm. Ross Monash, 23 October 2006). Therefore any artificial lighting from the proposed development is not likely to impact turtle nesting in the region.

9.4.4 Mitigation Strategies

While there are no nesting beaches in the vicinity of Shute Bay, Shute Harbour Marina Developments considers it to be best practice to limit light emissions from the development. Artificial light management for the Shute Harbour Marina Development will include:

- controls on night-time activities requiring lights;
- encouragement/education about turning off lights;
- use of timers and motion detectors for external lights;
- shielding of lights along roads to reduce excessive lighting;
- use of 'bug' lights (yellow-tinted incandescent lights) for all external lighting (in conjunction with shields, timers and motion-sensors); and
- use of vegetation to shield lighting from the development footprint.

9.5 WATER QUALITY DEGRADATION

9.5.1 Risk Assessment Rating

Stormwater: Moderate risk = Unlikely likelihood x Minor consequence

9.5.2 Impact

Water quality in the Great Barrier Reef is an important issue as the effects of pollution and degradation can have a detrimental effect not only on the environment, but also the listing of the area as World Heritage. This in turn has significant impacts on industries such as tourism. Water quality in the Great Barrier Reef is influenced by industries such as agriculture, tourism, shipping and expanding urban centres. Run-off from these activities is the primary anthropogenic influence on water quality on the reef (Haynes, 2001).

9.5.3 Site Context

Water quality degradation is unlikely to result from the development and operation of the Shute Harbour Marina Development. Stormwater flows into Shute Bay are not significant even during the wet season when compared with tidal action. Although runoff is likely to contain sediment, rocks and leaf litter, the stormwater flows will have little effect on sedimentation within the bay. Shute Bay is one of the lowest energy areas within several kilometres of mainline coastline, and consequently acts as a sediment trap. The origins of sediment deposits within the bay are from erosion, estuary deposits and organic matter (SHMD, 2006).

While the bay acts as a sediment trap, thus limiting impacts beyond Shute Bay, best practice management and mitigation measures will be utilised to minimise potential impacts within the bay. Mitigation of impacts within the bay will further ensure minimisation of impacts outside the bay (SHMD, 2006).

It is anticipated that sediment quality will not be significantly impacted in the marina. Contamination of marinas is often associated with historic slipway and hull cleaning operations and use of antifouling hull paints such as TBT. Slipway and hull-cleaning operations will not be undertaken at the Shute Harbour Marina Development and the use of TBT paints is now outlawed on vessels of the size likely to use the marina. A survey of sediments for dredging operations in Port Binnli's Reef Marina at Mackay in December 2006, approximately 6 years since the beginning of marina operations, demonstrated that all contaminants surveyed (heavy metals, TPH, BTEX) were either below *Interim Sediment Quality Guideline* (ANZECC/ARMCANZ, 2000) low levels or below levels of laboratory detection (HLA Envirosciences, 2007).

9.5.4 Mitigation Strategies

To ensure that the ecological processes, communities, and species are protected and ecosystem function is maintained within Shute Bay, management and mitigation measures are being developed for all stages of the project.

During the design phase, measures will include:

- The use of gross pollutant traps, and stormwater quality improvement devices to remove gross and fine sediments prior to water discharge to Shute Bay;
- Use of oil separators to remove oils from car parking areas; and
- Project design to include water sensitive urban design principals.

During construction, management and mitigation measures will include:

- Use of sediment curtains around the dredging site and around the marina facility on the breakwater during construction; and
- Management of dredge return water through use of settling ponds with weir boxes and / or geofabric bags for rapid dewatering. Return water releases will be monitored against site specific water quality objectives based on turbidity measurements in Shute Bay.

During operation, management and mitigation measures will include:

- Regularly inspect gross pollutant traps, stormwater quality improvement devices oil-water separators;
- Remove litter, sediments and other contaminants to maintain operating efficiency.

Further information on mitigation strategies is provided in Section 10.0.

9.6 SEWAGE DISCHARGE

9.6.1 Risk Assessment Rating

Significant risk = Virtually Certain x Negligible consequence

9.6.2 Impact

The discharge of sewage from boats potentially contributes to reduced water quality, poses a human health risk and decreases visual aesthetics of Queensland's waterways, particularly in coastal areas.

Increased nutrient and pathogen loadings can affect coral reefs and tropical seagrasses particularly in poorly flushed areas such as bays and lagoons. Localised effects on the coral reef include reduced species diversity, lower coral cover and suppressed coral recruitment (GBRMPA, http://www.gbrmpa.gov.au/corp_site/key_issues/water_quality/vessel_sewage_regs). Elevated nutrients can impact seagrass and macroalgae communities through epiphytic algae growth that smothers the marine plants and therefore reduce the availability of food resources to herbivorous/omnivorous marine turtles and mammals. The introduction of sewage may lead to diseases in marine mammals, for example toxoplasmosis which is linked to domestic cat faeces.

The release of sewage into Queensland waters is regulated under the Queensland *Transport Operations (Marine Pollution) Act* 1995 (TOMPA) and the *Transport Operations (Marine Pollution) Regulation* 1995. Under this legislation, it is illegal to discharge sewage (treated or untreated) into a marina, which is included under the definition of "prohibited discharge waters". The release of sewage is also regulated under the *Environment Protection Act* 1994.

9.6.3 Site Context

It should be noted that the entire development will be serviced by Whitsunday Shire Council's sewerage scheme and preclude any site discharge of effluent (SHMD, 2006).

As described in Section 0, it is illegal for vessels to discharge sewage into the waters of the marina. Nevertheless, it is almost inevitable that small volumes of sewage could occasionally enter the marina through either accidental or intentional discharge. In order to minimise the potential for domestic animal faeces to enter the waterway, SHMD have decided to prohibit cats and dogs from being kept as pets in the marina or residential area of the development. It is possible,

however, that droppings may enter the waterway through cat or dog being walked along the public access areas, including the boardwalk.

The volumes of sewage or droppings that would enter the waters would be small and produce negligible impact to water quality. Flow-on effects to megafauna would similarly be negligible, especially since Shute Bay does not appear to represent critical or significant habitat to marine megafauna species.

Sewer from land leased buildings will be serviced by a reticulated system.

9.6.4 Mitigation Strategies

While the consequence of discharge of small quantities of sewage into the marina and Shute Bay is likely to be negligible, measures can be implemented to reduce the likelihood of occurrence, and represent best management practice for marinas. Minimum measures to be implemented at the Shute Harbour Marina Development include:

- Provision of sullage pump-out facilities within the marina;
- Inclusion of fees for sullage pump-out facilities in berthing dues so that patrons perceive it as an included service, rather than an additional cost, and hence are more likely to use it;
- Provision of information materials on legal requirements and facilities provided at the marina; and
- Provision of land-based toilet and shower facilities to encourage patrons not to use their on-board facilities; and
- Prohibition of use of onboard toilets and showers, unless the waste water is kept in the holding tank and disposed of appropriately.

Additional measures being considered by Shute Harbour Marina Development include:

- Placement of coloured dye by marina operators in on-board toilets so that discharge will be observable and traceable; and
- Placement of brightly coloured bungs by marina operators to seal up the discharge holes.

The potential for dog and cat faeces to enter the marina and Shute Bay will be limited by the following:

- Development of a Stormwater Management Plan;
- Requirement that any droppings in public areas are picked up and disposed of by the animal's owner;
- Provision of plastic bag and disposal facilities on public access areas;
- Requirement that dogs are kept on leash in public areas;
- Policy that dogs and cats cannot be kept on vessels within the marina; and
- Requirement that dogs and cats are prohibited from being kept in residences.

9.7 HABITAT/FOOD SOURCE LOSS

Habitat and food loss are intrinsically linked, so are considered together here.

9.7.1 Risk Assessment Rating

Within project site:

Significant = Likely likelihood x Minor Consequence; or
= Virtually certain likelihood x Negligible consequence

Outside project site:

Moderate = Unlikely likelihood x Minor consequence

9.7.2 Impact

Habitat destruction (and food source loss) is an issue that is prevalent across all ecosystems. Given the high mobility of marine animals the effects of habitat destruction and loss appear to be comparatively less critical than those of aquatic and terrestrial environments (Harwood, 2001). The mobility of marine animals aside, habitat destruction and food source loss in coastal areas can have a significant effect on local and habitat specialist populations.

Harwood (2001) defines critical habitat for marine mammals in terms of the functioning ecological units required for successful breeding and foraging, and cites Ray (1976) whose definition of critical habitat as "those identifiable areas which are vital to the survival of a marine species at some phase in its life cycle".

9.7.3 Site Context

Construction of the Shute Harbour Marina Development will result in loss of about 35 ha of intertidal and subtidal habitat. About 14 ha, of sparse seagrass will be lost from within the development footprint representing approximately 10% and 0.00028% of that recorded in Shute Bay and the GBRWHA respectively (FRC Environmental, 2008). Approximately 14.7 ha of seagrass will be impacted by altered hydrodynamics within Shute Bay, although there is likely to be little net loss/gain. A further 4.18 ha of seagrass is likely to be temporally impacted by elevated suspended solids and sediment deposition associated with dredging (FRC Environmental, 2008).

The sparse seagrasses are dominated by *Halodule uninervis*, which is a preferred food source for dugong and herbivorous turtles, especially the Green turtle.

Dugong are not known to use Shute Bay and the project area does not appear to represent significant habitat. No sightings or feeding trails have been recorded in the bay. It is expected that the sparse seagrass present in the bay may not be attractive to dugong, especially when larger and more dense meadows occur elsewhere in the region.

Green turtles have been recorded from Shute Bay but sightings are infrequent. The dominant seagrass, *Halodule uninervis*, is a preferred food for the Green turtle, however, the sparse nature of the seagrass in Shute Bay may not represent favoured habitat. A significant habitat would be expected to be regularly frequented by turtles. There are no known turtle nesting beaches in the area, so the site appears to have limited value from a nesting perspective. Use of the bay by turtles appears to be minor and infrequent.

In the risk assessment undertaken in Section 0, several scenarios were tested to provide a level of sensitivity analysis for risks to megafauna with regard to loss of habitat and food sources within Shute Bay. These ranged from loss of sparse seagrasses (less than 0.5% cover) within the construction footprint, to total loss of seagrasses within Shute Bay (including small patches of seagrass with up to 5% cover). Risks associated with loss of habitat and food sources from with the construction footprint were rated as Significant, while risks outside the footprint were rated as moderate.

It is likely that a loss of food sources within the marina development could be partially offset by the growth of algae and associated marine fauna on tidal structures. A survey of aquatic conditions at Port Binnli's Reef Marina, Mackay, demonstrated a diverse array of habitats, including several types of sedimentary habitat and solid surfaces (pylons, pontoons and breakwater) (The Ecology Lab, 2003). After three years of marina operation, the surfaces of solid structures, particularly the pontoons, supported a very diverse assemblage of plants and animals, including algae, oysters, barnacles and ascidians. During the field survey a marine turtle was observed twice grazing on sea lettuce (*Ulva* sp.) growing on the

pontoons. The breakwater supported a very different group of plants and animals – surfaces were mainly dominated by fine silt matrix, although there was colonisation of some rocks by several species of hard corals.

9.7.4 Mitigation Strategies

As part of best practice environmental management, construction and operation of the marina development will be undertaken to minimise the footprint of the construction impacts and minimise potential for water quality impacts on seagrasses within the bay as well as corals in adjacent inshore reefs. This will include:

Constraining the dredging and marina construction to the approved footprint;

Using silt curtains around dredging and construction areas;

Managing and monitoring dredge return water to reduce sediment loads that could smother seagrasses;

Impacts to seagrass communities within Shute Bay will be monitored, at least during the construction phase of the project; and

Negotiation of offsets for seagrass and mangrove losses with Department of Primary Industries and Fisheries (DPI&F). This may include mangrove revegetation of the western side of the isthmus.

9.8 COASTAL DEVELOPMENT

9.8.1 Risk Assessment Rating

Moderate risk = Rare likelihood x Major consequence

9.8.2 Impact

The expansion of coastal urban development has placed increasing pressure on the natural environment through problems such as habitat loss, waste disposal and pollution (cited in ABS, 2004a). Despite this, Chilvers *et. al.* (2005) have shown that diverse and abundant populations of marine animals can coexist within an area of high growth and coastal development, however, there is still concern over the effects that such growth has and will have in the future on these populations.

As of June 2001, approximately 88% of Queensland's population lives within 50km of the coast and the number is rising (ABS, 2004b). As a consequence coastal areas are among the marine habitats most at risk from impacts associated to human activities (Parra *et. al.*, 2006).

9.8.3 Site Context

The Mackay / Airlie Beach region has been identified by the Australian Bureau of Statistics as a high growth coastal region whereby the residential population of the area exceeds the average national growth rate of 1.2%. As well as high population growth rates Airlie Beach is considered the "Gateway to the Whitsunday Islands". The Shute Harbour Marina Development will form part of the coastal development within the region.

9.8.4 Mitigation Strategies

Where possible, SHMD will also contribute to regional planning and sustainable management practices within the region, as key coastal stakeholders in the area. In addition various management measures are proposed as part of the SHM development to mitigate and/or avoid impacts associated with coastal development, refer to EIS for more detail.

9.9 OIL SPILL

9.9.1 Risk Assessment Rating

Frequent minor spills (e.g. refuelling):
Significant Risk = Virtually certain likelihood x Minor consequence

Infrequent major spills (e.g. ruptured refuelling hose or vessel collision):
Significant Risk = Likely likelihood x Major consequence

9.9.2 Impact

Polycyclic aromatic hydrocarbons (PAHs) account for 20% of total hydrocarbons in crude oil and are the most biologically toxic of all the petroleum compounds (Haynes, 2001). Oil spills generally contain a mix of hydrocarbons which have differing effects on the environment, such as cell mutagen and carcinogen (cited in Haynes, 2001). The most significant impacts of an oil spill are on larvae and organisms that have low motility, and hence cannot escape the oil. Typical impacts include changes in feeding or reproductive cycles that ultimately affect population size and fecundity. Once the PAHs have settled into the sediment, filter feeders and benthic organisms are affected with the bioaccumulation of toxic compounds into their tissues, this leads to genetic mutations and cell degeneration (Haynes, 2001). Between 1987 and 1997 there were 192 minor oil spills in the Great Barrier Reef World Heritage Area (Haynes, 2001); this indicates that oil spill is a relatively common event which should not be ignored.

Marine megafauna can be affected by an oil spill in a number of different ways. A common side effect of an oil spill is the poisoning of wildlife higher up the food chain, such as marine mammals and turtles, when they eat organisms as described above. This may make animals too ill to breed or interfere with breeding behaviour. Marine mammals and turtles may also be effected by breathing in oil droplets or fumes leading to damage to the airways, congestion, pneumonia, and emphysema. Damage may also be done to the eyes, causing ulcers, conjunctivitis and blindness. This can lead to starvation as animals will be impaired in finding food. Oils can also cause irritation or ulceration of the skin, mouth and nasal cavities and suppress the immune system causing bacterial or fungal infections (http://www.amsa.gov.au/marine_environment_protection/educational_resources_and_information/teachers/the_effects_of_oil_on_wildlife.asp)

In areas of turtle nesting, indirect impacts could include the contamination of turtle nesting beaches leading to contamination of the eggs, adult turtles moving up the beaches and newly hatched turtles. There may also be damaging to estuaries, coral reefs, seagrass and mangrove habitats which form part of the habitat for many marine megafauna as discussed above (http://www.amsa.gov.au/marine_environment_protection/educational_resources_and_information/teachers/the_effects_of_oil_on_wildlife.asp)

9.9.3 Site Context

As the new development includes a marina, where refuelling will be undertaken, there exists potential for a fuel spill to occur. Fuel spillage or release of oil may also occur in the event of a significant boating accident or through the sinking of a vessel within the marina. A significant release of fuel or oil in the marina could impact on seagrass, mangrove and fringing coral resources in Shute Bay.

The potential for these to occur (i.e. likelihood) will be reduced through best practice measures during construction and operation of the development.

9.9.4 Mitigation Strategies

During construction over water, best practice oil and fuel handling and use aboard the barges will be enforced in order to reduce the risk of accidental spillage. The Construction EMP will describe the fuel handling and storage procedures, this will include:

- Oil spill kits of sufficient capacity will be available at all times aboard the tugs and barges;
- Used oil being placed in the appropriate waste container for recycling; and
- All wastes being transported to land, collected and treated or recycled, as appropriate.

SHMD is also considering purchasing a purpose-built vessel that will include fire fighting and oil spill response, in addition to other uses such as rubbish collection. This vessel will be available during the operations of the marina, but potentially also the construction phase. SHMD will also make the vessel available for fire and oil spill first-response duties within the Shute Harbour / Airlie Beach area, providing a level of response that is currently not available. Operators and crews of these vessels will be trained in the use of these kits.

SHMD have advised that during operation of the marina, refuelling of vessels will be undertaken only at the refuelling berth, where spill containment equipment will be available nearby. Fuel storage tanks will be double skinned to minimise potential for leaking. During refuelling, the following procedures will be followed to minimise the potential for fuel spillage:

- Dispenser hand piece must be attended at all times (It is illegal for the hand piece to be "chocked" open);
- Containers to be placed underneath breathers and overflow pipes;
- Use of leak detection devices;
- Signage prohibiting “topping off” once fuel tank is full; and
- Use of fuel collars with fuel absorbent material on filling nozzles.

Further, berthed vessels in the marina will also be required to place oil absorbent pads in their bilge and dispose of them appropriately in the provided oil bins upon their departure or replaced when the pads are full.

In the event of an oil/fuel spill, the following actions will be required as part of operational management:

- Advise marina management;
- Take every safe action to contain the spill;
- Marina management to initiate first-response using the purpose built vessel to contain spill and begin soaking up the spill using fuel spill containment equipment;
- Advise Regional Harbourmaster and the Environmental Protection Agency of any significant oil spill; and
- If required, analysis of sediments for PAH fractions following major spill, to determine the level of contamination and need for remediation.

9.10 DREDGING

9.10.1 Risk Assessment Rating

Moderate risk = Rare likelihood x major consequence

9.10.2 Impact

Dredging generally can impact marine megafauna, particularly dugong and turtles, both directly and indirectly. Dredging activities can directly impact turtles via physical injury and mortality through the dredging process depending on the type of dredging equipment used. Trailing arm suction dredges, which essentially vacuum up soft sediments from the seabed, have been responsible for multiple turtle mortalities in Queensland. These vessels are relatively large and mobile vessels compares to other dredge types. To reduce risks of turtles being impacted through intake, turtle exclusion devises are being installed on vessels with this type of dredging process. Other dredge types, such as cutter-suction dredgers and bucket dredgers are less likely to impact turtles as they are slow moving over a dredge area and turtles have time to escape.

Indirectly, dredging can impact megafauna through impacts to seagrass beds, which are a major food source for dugong and some turtles, Green turtles in particular. Dredging can remove seagrass and benthic food resources and stir up large amounts of sediment that smother seagrasses.

9.10.3 Site Context

Construction dredging at the Shute Harbour Marina Development requires dredging of the marina basin and entrance channel and would be undertaken under an approved dredge management plan or operational works approval. Dredging is proposed to be undertaken using a cutter-suction dredge and possibly bucket dredgers. Use of these dredge types will limit the likelihood of turtles or other megafauna being directly impacted by dredging equipment. Similarly, maintenance dredging during marina operation will be undertaken using cutter suction dredges, which again limits the potential for megafauna to be directly impacted.

Maintenance dredging is expected to be required every five to seven years. Maintenance dredging is not anticipated during the first ten years of operation due to construction overdredging.

Dredging using cutter-suction dredges typically results in a high percentage of water in the dredged slurry. This slurry is typically highly turbid and requires appropriate management so that suspended sediment levels in the return water are suitable for the receiving environment with regard to water quality and sensitive habitats (e.g. seagrasses and coral reefs). Actual sediment disturbance around cutter-suction dredge heads is relatively minor as disturbed material is vacuumed up in the process.

9.10.4 Mitigation Strategies

Construction and maintenance dredging operations will be undertaken using cutter-suction type dredgers. If one of these is not available and a suction dredge is used, it must be fitted with turtle deflection devices such as tickler chains leading in front of the suction head. These function to prompt the turtle to move away from the suction head.

Dredging operations will be suspended if a turtle, dugong or other marine megafauna is observed within the marina construction area bounded by the silt curtain, which will extend from the water surface to the sea bed across the marina entrance, or observed within 200m of the dredge operating in the entrance channel. 200m is the realistic maximum line of observation of megafauna (especially turtles) from the dredging vessel[1]. Dredging will only continue after any animal that has entered the construction area is again outside the marina construction area through herding or removal by QPWS/EPA personnel or their representative, or outside the 200m observation zone. The dredge master (or his delegate) will be responsible for visual survey for turtles (using binoculars) at least every half hour.

[1] There is a recent precedent of a 200m observation zone for the Port of Bundaberg's Sea Dumping Permit.

In the event of an injury or mortality to megafauna from dredging activities, the works supervisor or marina manager will advise QPWS / EPA immediately. Works will be suspended until QPWS/EPA and Shute Harbour Marina Development review operational procedures and equipment to determine strategies to reduce injury or mortality from recurring.

In order to minimise the potential for not seeing marine fauna at night, dredging will not be undertaken at night under normal circumstances. Night dredging may be required in emergency situations (e.g. deposition of silt following flood), or if the dredging program falls more than one month behind schedule due to weather or operational circumstances. No additional management measures are anticipated in the event that night dredging occurs as night dredging is common in port dredging programs in Queensland and additional measures are not required as part of this dredging projects.

Dredging return water will be managed during construction and maintenance dredging operations to reduce suspended sediment loads. This will be achieved by using either settling ponds with weir boxes or sausage-shaped geofabric bags used for rapid dewatering. Return waters will be monitored to comply with site specific water quality objectives based on background ambient conditions and environmental values present within Shute Bay. These are being developed within the water quality assessment component of the impact assessment studies for the project.

9.11 MARINE CONSTRUCTION

9.11.1 Risk Assessment Rating

Moderate risk = Likely likelihood x Negligible consequence

9.11.2 Impact

Marine construction activities can impact on marine megafauna in many of the ways described above (e.g. habitat/food source depletion, water quality degradation, dredging etc). In addition to these, impacts to megafauna can also occur through physical displacement of animals, harassment, noise impacts through pile driving and human presence and activity.

The major construction of marine facilities typically may lead to temporary avoidance of the area by marine megafauna.

9.11.3 Site Context

Construction of the Shute Harbour Marina Development is expected to take approximately 2-3 years, although the construction of the marina basin itself will take significantly less time than this. During marina construction, it is expected that marine megafauna would avoid Shute Bay, particularly during noisy activities such as pile-driving.

9.11.4 Mitigation Strategies

The construction program will be sensitive to potential impacts to marine megafauna. Mitigation strategies (in addition to those described in other sections) will include:

- Minimise periods of major marine construction activities, such as pile-driving and dredging;
- Where feasible, limit noisy construction activities to times outside migration period for Humpback whales (i.e. outside July to October);
- Minimise use of rope within water to avoid entanglement. If it is used, encase it in conduit pipe where practical. Alternatively, use light chain;

- Ensure turtles, or other marine megafauna are removed, under supervision of QPWS staff, from behind the sheet-pile wall when they are observed during construction; and
- No use of explosive charges during marine construction activity.

9.12 Other Priority Mitigation, Monitoring and Research Recommendations

Workshop participants were invited to propose other priority mitigation, monitoring and research recommendations for consideration by the proponent, Shute Harbour Marina Development. This was undertaken so that recommendations could be made regarding and identified significant gaps in knowledge that need to be addressed and to provide a forum to discuss risks characterised as Negligible and not considered in the detailed discussion of Significant and Moderate risks.

Additional recently published, in-press and unpublished material was provided by Amanda Hodgson and Kirstin Dobbs to supplement existing information on several megafauna species and in relation to boat strike and boating disturbance impacts.

Workshop participants proposed additional risks to be assessed, including:

- Boating disturbance;
- Water quality reduction from sewage discharge;
- Food source loss (at a regional level);
- Frequent minor oil spill during refuelling; and
- Detailed risk assessment of crocodile attacks on marina patrons.

All but the last risk were considered collectively at the workshop and have been included in the risk assessment section. The risk of crocodile attack was not assessed in this workshop because general consensus was that it should be the subject of its own risk assessment. Further, the focus of the workshop was on protecting megafauna from impact, whereas potential for crocodile attacks is a safety issue and outside the scope of the workshop and this study.

No recommendations for monitoring of megafauna populations or priority research were proposed at the workshop.

10.0 CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

10.1 CONCLUSIONS

The Shute Harbour Marina Development proposed to be constructed in Shute Bay, Queensland, has the potential to impact on a range of marine turtle and mammal species, which are protected under State and Commonwealth legislation. Marine megafauna species that have either been recorded in Shute Bay, or may be reasonably expected to occur there because suitable habitat or food sources exist, include: dugongs, flatback turtles, green turtles, loggerhead turtles, and hawksbill turtles. While Shute Bay may present suitable habitat or food sources to these species, the bay is not considered to be of critical or high importance since usage of the area appears to be relatively low, possibly due to relatively sparse resources when compared to other areas within the Whitsunday region. Of particular importance is the understanding that no turtle nesting beaches occur in or near Shute Bay and no major breeding sites occur within the Whitsunday area.

Other significant species would occur in the Whitsunday region but would not occur within the bay. For example, the Humpback whale does not occur within Shute Bay, but is known to frequent the Whitsunday islands and passage, which are important resting and breeding grounds for this species. Inshore dolphin species, Australian snubfin dolphin and Indo-Pacific humpback dolphin, are not expected to occur in Shute Bay as the bay is outside the dolphins' range from the nearest significant estuaries where they might occur. Leatherback turtles would also not occur within Shute Bay as they prefer pelagic habitats, however they might occur in the Whitsunday region.

A risk assessment process that included a workshop, with input from megafauna experts and regulatory agencies, determined that there were no potential impacts from the construction or operation of the Shute Harbour Marina Development that represented an "intolerable risk" which cannot be justified. Several "significant risks" were identified relating to: boating disturbance and boat strike, local habitat/food source loss, oil spills, marine debris and minor incidental sewage discharge. Effective measures can be actioned at a senior management level to reduce these risks. These include measures through the design, construction and operational phases of the project. Experts expressed that boating disturbance and boat strike were the most critical of these risks, and will require responses at the local and regional level with a particular focus on regularly educating boat users about best management practice.

Moderate risk potential impacts relevant to marine megafauna include: coastal development cumulative effects, construction in the marine environment, dredging impacts on water quality, loss of invertebrate and seagrass as food sources in Shute Bay, artificial lighting, and water quality degradation. These impact risks can be managed through the implementation of cost effective measures and formalise routine measures.

10.2 MANAGEMENT RECOMMENDATIONS

Appropriate management regimes require implementation. Management recommendations contained in this report aim to ensure that impacts to turtle, dugong, whale and dolphin populations through the design, construction and operational phases of the Shute Harbour Marina Development are minimised. The following tables list the management recommendations required to minimise risks to these fauna. Table 10.1 to Table 10.3 summarise the various management tasks outlined in Section 9.0 of this report. These tasks are the minimum standard to be applied to the management of marine megafauna at SHMD.

TABLE 10.1 DESIGN PHASE MANAGEMENT RECOMMENDATIONS

IMPACT / TASK NO. (D=DESIGN TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
BOAT STRIKE			
D1	Design entrance channel to include lateral overdredging at sides to form coves where turtles can rest outside navigation channel.	Dredging design engineers	Include design justification in tidal works development approval
D2	Design entrance channel to include depth overdredging at sides to form gutters where turtles can rest below level of propeller action.	Dredging design engineers	Include design justification in tidal works development approval
D3	Contribute as a key regional stakeholder to the proposed regional boating traffic management plan to be developed by the Qld Government.	Shute Harbour Marina Development	Nil
BOAT DISTURBANCE			
D4	Contribute as a key regional stakeholder to the proposed regional boating traffic management plan to be developed by the Qld Government.	Shute Harbour Marina Development	Nil
HABITAT/ FOOD SOURCE LOSS (LOCAL)			
D5	Proponent to negotiate offsets for seagrass and mangrove losses with relevant regulatory agency (DPI&F). This may include mangrove revegetation on the western side of the isthmus.	Shute Harbour Marina Development and consultant marine ecologists	Prior to construction
OIL SPILLS			
D6	Design fuel storages with double skins. Include leak detection devices in fuel supply design.	Development design engineers	Include design in relevant approval application.
MARINE DEBRIS			

IMPACT / TASK NO. (D=DESIGN TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
D7	Gross pollutant traps to be included in stormwater design.	Development design engineers	Include design justification in construction development approval.
SEWAGE DISCHARGE			
D8	Include design of sullage pump-out facilities in marina development		
D9	Include land-based shower and toilet facilities for marina berth patrons. The entire development will be serviced by Whitsunday Shire Council's sewerage scheme and preclude any site discharge of effluent.	Development design engineers	Include design in construction development approval.
COASTAL DEVELOPMENT			
D10	Incorporate best practice environmental management into marina development design and operation management plan to minimise overall impact of development in Whitsunday region.	Development design engineers	EIS to address principles of Environmentally Sustainable Development
MARINE CONSTRUCTION			
D11	Develop draft and final Construction EMP.	Project engineers Construction contractor	Construction draft EMP to be included in EIS and Development Approval. Construction contractor to develop final EMP.
DREDGING			
D12	Construction tender documentation to specify use of cutter-suction dredge for development dredging.	Dredging design engineers	
D13	Develop site specific water quality objective for	Dredging design engineers	Water Quality Objectives to be included in EIS,

IMPACT / TASK NO. (D=DESIGN TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
	turbidity. These will act as trigger-levels used in the dredging return-water monitoring program. WQOs must be designed to protect seagrass food sources in Shute Bay from being indirectly impacted through light reduction.		dredging development approval documentation, and construction EMP.
FOOD SOURCE LOSS (REGIONAL)			
D14	Implement management tasks relating to habitat/food source loss at local level (refer D5). This would best minimise impacts at regional level.	NA	NA
ARTIFICIAL LIGHTING			
D15	Development lighting plan to include the following: Timers and motion detectors for external lights Shielding of external lights along roads to reduce light entering marine environment Yellow tinted incandescent lights ("bug lights") for all external lighting Use vegetation to shield lighting from development.	Electrical design engineers Landscape architects	Include design justification in lighting/electrical design plan.
WATER QUALITY DEGRADATION			
D16	Gross pollutant traps, sediment traps and oil-water separators to be included in stormwater design.	Development design engineers	Include design justification in construction development approval.
D17	Project design to include water sensitive urban design principals.	Development design engineers and landscape architects.	Include design justification in construction development approval.

TABLE 10.2 CONSTRUCTION PHASE MANAGEMENT RECOMMENDATIONS

IMPACT / TASK NO. (C=CONSTRUCTION TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
BOAT STRIKE			
	Nil		
BOAT DISTURBANCE			
	Nil		
HABITAT/ FOOD SOURCE LOSS (LOCAL)			
C1	Constrain construction footprint to approved area.	Construction contractor works supervisor	Project engineers to provide "as constructed drawings" and submit to EPA.
C2	Monitor seagrass communities within Shute Bay according to approved seagrass monitoring plan. Implement management actions as required under that plan.	Shute Harbour Marina Development Marine ecology consultant	Monitoring report to be submitted to EPA, including discussion of management actions taken and recommendations for improvement.
C3	Implement agreed seagrass and mangrove habitat management strategy.	Construction contractor works supervisor Marine ecology consultant	Include report on implementation success within seagrass monitoring report.
OIL SPILLS			
C4	Oil spill management plan to be developed by construction contractor and implemented during construction phase of project. If available, position the purpose built fire-fighting, oil spill response and rubbish collection vessel on-site for spill response or fire fighting.	Construction contractor works supervisor Shute Harbour Marina Development	Oil spill management plan to be included in construction contract.
MARINE DEBRIS			

IMPACT / TASK NO. (C=CONSTRUCTION TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
C5	Existing marine debris within the development area to be removed during construction process.	Construction contractor works supervisor	
C6	Debris created during the construction process is to be managed through a waste management plan to be developed by construction contractor and implemented during construction phase of project.	Construction contractor works supervisor	Waste management plan to be included in construction contract.
SEWAGE DISCHARGE			
C7	Toilet facilities to be available onshore during construction phase.	Construction contractor works supervisor	Nil
COASTAL DEVELOPMENT			
	Nil		
MARINE CONSTRUCTION			
C8	Limit noisy construction activities (e.g. piledriving) to outside July to October (inclusive) as far as practicable.	Construction contractor works supervisor	Nil
C9	Minimise use of ropes in water through use of light chain, or alternatively cover ropes using conduit.	Construction contractor works supervisor	Nil
C10	Remove turtles or other marine megafauna from behind sheet-pile walls when observed during construction. Removal to be undertaken or supervised by Queensland Parks and Wildlife Service.	Construction contractor works supervisor	Contact QPWS (Whitsunday Office) on 4946 7022; or Marine Strandings & Pollution Hotline on 1300 130 372 (24 hr) and advise of situation.
C11	No use of explosive charges in water.	Construction contractor works supervisor	Nil
DREDGING			

IMPACT / TASK NO. (C=CONSTRUCTION TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
C12	Silt curtain to be used around the dredging activities.	Construction contractor works supervisor	Nil
C13	Second silt curtain to be established along breakwater following construction.	Construction contractor works supervisor	Nil
C14	No night time dredging activity under normal circumstances. Night time dredging only if emergency dredging is required or if the project falls more than one month behind schedule.	Construction contractor works supervisor	Nil
C15	Dredge master or delegate to observe for marine turtles, dugong, whales or dolphins each half hour, using binoculars.	Dredge vessel master	Record sightings (or lack thereof) in Sightings Log.
C16	Suspend dredging operations if turtles, dugongs, whales or dolphins are observed within the sediment curtain bounds of the construction area. Recommence operations only when animal is outside the area.	Dredge vessel master	Record suspended operations in vessel log
C17	Immediately report any injury or mortality to Queensland Parks and Wildlife Service.	Construction contractor works supervisor	Contact QPWS (Whitsunday Office) on 4946 7022; or Marine Strandings & Pollution Hotline on 1300 130 372 (24 hr) and advise of situation.
C18	Monitor dredge return water according to agreed water quality monitoring plan, including turbidity.	Environmental consultant	As per requirements under the agreed water quality monitoring plan.
FOOD SOURCE LOSS (REGIONAL)			
	Nil		
ARTIFICIAL LIGHTING			

IMPACT / TASK NO. (C=CONSTRUCTION TASK NO.)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
C19	Construct external lighting in accordance with the lighting electrical plan.	Construction contractor works supervisor	Nil
WATER QUALITY DEGRADATION			
C20	Monitor water quality according to agreed water quality monitoring plan.	Environmental consultant	As per requirements under the agreed water quality monitoring plan.

TABLE 10.3 OPERATIONAL PHASE MANAGEMENT RECOMMENDATIONS

IMPACT/ TASK NO. (O=OPERATIONAL TASK NO....)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
BOAT STRIKE			
O1	Implement agreed activities under the regional boating traffic management plan to be developed by the Qld Government.	Shute Harbour Marina Development	Nil
O2	Provide signage to public boat ramp and install signage on marina walkways promoting general boating best practice environmental management.	Shute Harbour Marina Development	Nil
O3	The GBRMPA can provide information regarding best practice environmental management for boating. Include flyers in berthing application packs. Keep flyers on display in marina office. Provide best practice information in Environmental section of monthly newsletters to marina patrons.	Shute Harbour Marina Development	Nil
O4	Promote and "enforce" the six knot speed limit within the designated Shute Harbour area. Visually assess and photograph vessels at planning speed within the designated area. Remind offenders of the speed zone and SHMD "three strikes" policy, whereby persons or vessels breaching the speed limit on three or more occasions have their berthing privileges rescinded and are asked to leave the marina.	Shute Harbour Marina Development marina operators	Record breaches of policy and advice to offending vessel owners and operators.
BOAT DISTURBANCE			
O5	The GBRMPA can provide information regarding best practice environmental management for boating. Include flyers in berthing application packs. Keep flyers on display in marina office.	Shute Harbour Marina Development	Nil

IMPACT/ TASK NO. (O=OPERATIONAL TASK NO....)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
O6	Implement agreed activities under the regional boating traffic management plan to be developed by the Qld Government.	Shute Harbour Marina Development	Nil
HABITAT/ FOOD SOURCE LOSS (LOCAL)			
O7	Monitor seagrass communities within Shute Bay according to approved seagrass monitoring plan, which will be developed to support SHMD marine plant application. Implement management actions as required under that plan.	Shute Harbour Marina Development Marine ecology consultant	Monitoring report to be submitted to DPI&F, including discussion of management actions taken and recommendations for improvement.
OIL SPILLS			
O8	Implement management measures to minimise minor fuel spillage during boat refuelling: Attend dispenser at all times during filling No chocking open of dispense Place containers underneath breathers and overflow pipes Use fuel collars and absorbent material on filling nozzles Prohibit topping off of fuel once full Fuel spill equipment to be located near filling point Wipe up small spills with rag and dispose of in waste bin.	Shute Harbour Marina Development or marina operators	Include actions in Operations Plan for marina. Provide filling instructions at fuel berth. Train relevant staff on refuelling methods.
O9	Implement management measures to manage major oil/fuel spill: Take every safe action to stop spillage Advise marina management of spill Marina management to contain spill and soak up spill using fuel spill containment equipment. Deploy the purpose built fire-fighting, oil recovery and waste collection vessel if spill is moderate to large or other	Shute Harbour Marina Development or marina operators	Include actions in Operations Plan for marina. Provide major spill management instructions at fuel berth. Train relevant staff on major spill containment methods.

IMPACT/ TASK NO. (O=OPERATIONAL TASK NO….)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
	containment methods fail. Advise regional harbourmaster of any significant oil spill Analyse sediments for PAH fractions following major spill to determine level of contamination and need for remediation.		
MARINE DEBRIS			
O10	Negotiate commercial waste agreement with Whitsunday Shire Council and waste contractor.	Shute Harbour Marina Development or marina operators	Contract on file with Shute Harbour Marina Development
O11	Provide bins for rubbish collection and recycling near marina berth area.	Shute Harbour Marina Development or marina operators	Nil
O12	Place signage around marina berth area and boardwalk that it is an offence to litter.	Shute Harbour Marina Development or marina operators	Nil
O13	Implement a litter collection program within the marina development.	Shute Harbour Marina Development or marina operators	Nil
O14	Regularly inspect gross pollutant traps and remove accumulated debris.	Shute Harbour Marina Development or marina operators	Nil
SEWAGE DISCHARGE			
O15	Include costs for sullage pump-out facilities in berthing dues.	Shute Harbour Marina Development or marina operators	Nil
O16	Provide information to marina patrons on legal requirement not to dispose of sewage in marina waters. Provide information to marina patrons on sullage pump-out, toilet and shower facilities provided at the marina.	Shute Harbour Marina Development or marina operators	Nil
O17	Investigate placing coloured dye in on-board toilets to detect sewage releases from boats.	Shute Harbour Marina Development or	Nil

IMPACT/ TASK NO. (O=OPERATIONAL TASK NO....)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
	Implement if practical.	marina operators	
O18	Investigate placing highly visible coloured bungs in sewage discharge holes of boats. Implement if practical.	Shute Harbour Marina Development or marina operators	Nil
O19	Implement policy of pet owners disposing of droppings in public places. Provide plastic bags and disposal facilities to enable this.	Shute Harbour Marina Development or marina operators	Nil
O20	Implement policy of dogs on leashes in public places.	Shute Harbour Marina Development or marina operators	Nil
O21	Prohibit the keeping of cats or dogs on vessels or in residences.	Shute Harbour Marina Development or marina operators	Nil
O22	Require that residences with dogs and cats must be fenced and cats kept inside at night.	Shute Harbour Marina Development	Nil
COASTAL DEVELOPMENT			
O23	Contribute to regional planning where appropriate as a stakeholder.	Shute Harbour Marina Development	Nil
MARINE CONSTRUCTION			
	Nil		
DREDGING			
O24	No night time dredging activity under normal conditions. Provision for night time dredging is provided if emergency dredging (flood related) is required or if the dredging program is significantly behind schedule.	Dredging contractor works supervisor	Nil
O25	Dredge master or delegate to observe for marine turtles, dugong, whales or dolphins each half hour, using binoculars.	Dredge vessel master	Record sightings (or lack thereof) in Sightings Log.
O26	Suspend dredging operations if turtles, dugongs, whales or dolphins are observed within 200 m radius of dredge head. Re-commence dredging only when fauna have left the 200 m radius zone.	Dredge vessel master	Record suspended operations in Vessel Log

IMPACT/ TASK NO. (O=OPERATIONAL TASK NO....)	TASK	PERSON RESPONSIBLE	REPORTING REQUIREMENTS
O27	Immediately report any injury or mortality to Queensland Parks and Wildlife Service.	Dredging contractor works supervisor	Contact QPWS (Whitsunday Office) on 4946 7022; or Marine Strandings & Pollution Hotline on 1300 130 372 and advise of situation.
O28	Monitor dredge return water according to agreed water quality monitoring plan, including turbidity.	Environmental consultant	As per requirements under the agreed water quality monitoring plan.
FOOD SOURCE LOSS (REGIONAL)			
	Nil		
ARTIFICIAL LIGHTING			
O29	Limit outside night time activities requiring lighting. Preferably limit activities to before 8pm.	Shute Harbour Marina Development or marina operators	Nil
O30	Encourage people to turn off lights once activities are completed through signage and word of mouth.	Shute Harbour Marina Development or marina operators	Nil
WATER QUALITY DEGRADATION			
O31	Monitor water quality according to agreed water quality monitoring plan.	Environmental consultant	As per requirements under the agreed water quality monitoring plan.
O32	Regularly inspect gross pollutant traps, stormwater quality improvement devices oil-water separators; Remove litter, sediments and other contaminants to maintain operating efficiency.	Shute Harbour Marina Development or marina operators	Nil

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Appendix A Addressing the Terms Of Reference

This Marine Megafauna Impacts Assessment and Management Plan specifically addresses parts of Section 4.9 of the Terms of Reference. Table A-1 identifies the section of this report that addresses the requirements of the Terms of Reference.

TABLE A.1 REPORT SECTIONS ADDRESSING THE TERMS OF REFERENCE

TOR SECTION	REPORT SECTION	HOW TOR ADDRESSED
1.6.1	3	Identifies legislation relevant to marine megafauna within the study area.
4.9.1	4 and 5	Section 4 lists marine megafauna species that have a range that includes the proposed project site. Section 5 identifies and describes the species that have a realistic potential to occur in the project area.
4.9.1.3	5	Describes mammal, turtle and crocodile species that may potentially occur within the study area from desktop analysis and expert advice. Identifies the relevance of the study area as habitat for these species.
4.9.2	9 and 10	From the risk assessment undertaken in section 8 of the report and the desktop analysis of species present in the area potential impacts and mitigation measures have been identified. This section discusses the impacts identified as 'significant' and 'moderate' in the risk assessment process. Section 10 details the management measures to be undertaken by SHMD in association with mitigation strategies identified in section 9. Includes impacts such as boat strike, marine debris, artificial lighting, water quality, habitat/food source loss and dredging.