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13. Nature Conservation – Marine

13.1 Existing Environment

13.1.1 Significance of the Marine Environment

Submissions have criticised the EIS for excluding information relating to the significance of the marine environment surrounding HHI.

Marine environment values were clearly set out in Section 15 of the EIS, which described areas of marine conservation significance including:

- The Great Barrier Reef Marine Park;
- The Great Barrier Reef Coast Marine Park;
- The Great Barrier Reef World Heritage Area;
- Nationally Important Wetlands;
- Regionally Important Wetlands;
- Fish Habitat Areas;
- Dugong Protection Areas (DPA); and,
- Areas of State Significance (Natural Resources).

The environmental significance of the waters surrounding Hummock Hill Island, including Colosseum Inlet, Boyne Creek, Seven Mile Creek, Rodds Bay, and adjacent waters, is acknowledged in Section 15 of the EIS. Ecosystems and species of particular conservation value or concern were listed and discussed in the EIS. Descriptions, assessments of potential impacts, and mitigation measures regarding all eight types of wetlands identified in Colosseum Inlet – Rodds Bay, which include marine waters (A1), seagrass beds (A2), rocky shores (A4), beaches (A5), estuarine waters (A6), intertidal flats including mud, sand and salt flats (A7), intertidal marshes (A8) and mangrove forests (A9), are provided in Section 15 of the EIS and in more detail in Appendix A7.11.

13.1.2 Environmental Values of Estuarine/Coastal Waters

One submission also stated that Hummock Hill Island is not in the Baffle Creek Catchment as stated in the EIS and that the Proponent ascribed no environmental values to estuarine or coastal waters of Hummock Hill Island.

Although Hummock Hill Island is not located in the catchment of Baffle Creek, it does lie in the Worthington Creek sub-catchment of the Baffle Creek Basin Catchment Planning Area, as defined by the Department of Environment and Resource Management and discussed in Section 9.2.7 of the EIS.

Further to this, Table 9-6 of the EIS does ascribe environmental values to the coastal and estuarine waters of Hummock Hill Island. Table 9-6 is reproduced below as **Table 13-1**.

Table 13-1 - Draft EVs for Estuarine and Coastal Waters around Hummock Hill Island

Watercourse Type	HCV Aquatic Ecosystems	Human Consumers of Aquatic Foods	Primary Recreation	Secondary Recreation	Visual Appreciation	Cultural & Spiritual
Estuarine Waters	✔✔	✔✔	✔✔	✔✔	✔✔	✔✔
Coastal Waters	✔✔	✔	✔✔	✔✔✔	✔✔✔	✔✔✔

As discussed in Section 9.2.7 of the EIS, a draft assessment of the ecological values of estuarine waterways and marine waters around Hummock Hill Island identifies the waters to be high conservation value primarily due to the relatively undisturbed nature of the estuaries and coastal habitat and presence of a number of protected species within the waters.

13.2 Impact of Boat Strike on Dugong and Turtles

As stated in the EIS, it is estimated that approximately 190 small boats will be owned by the permanent population of the development based on boat ownership rates in the surrounding coastal communities, with an estimated 19 - 29 boats in use on any given day (See Table 9.10 in the EIS). The 190 additional boats represents an increase of about 3% over total 2006 boat ownership in the Gladstone, Calliope and Miriam Vale LGA. In the event that the project does not proceed, it is expected that boat numbers will increase by 2,500 as a result of population increases in the region. Any increase in boat ownership attributable to the project is very minor, in comparison with expected overall increases in boat ownership.

13.2.1 Impacts on Dugong

Submissions raised the issue of potential impacts on dugongs due to boat strike. In addition to mortality and injury from direct boat strike, there is the potential for sub-lethal effects on dugong health, survival, and reproductive success from boat disturbance, including by boat noise, for example by disruption of feeding behaviour, increased energy expenditure (for example by inducing flight reactions), or displacement of dugongs from preferred feeding grounds.

Hodgson (2004) estimated that boat disturbance would reduce dugong feeding times by 0.8-6% in her Moreton Bay study area. She did not speculate that this represented a "significant impact", and concluded that at her site the possibility of boat strike was a greater risk to dugongs than disturbance. Boat strikes and habitat loss are also considered to be more important cause of dugong population decline than boat disturbance at a global scale (Marsh *et al*., 2002). It is therefore appropriate to consider boat strikes as the most important vessel-related impact associated with the development.

Given the relatively remote location of Hummock Hill Island, incidental sightings of dugongs from boats or the shore are not a reliable indicator of their abundance in the area. Regular, standardised aerial dugong surveys have been undertaken since 1986, however, and give reliable estimates relative to other parts of Queensland. Dugong population estimates for the Rodds Bay DPA derived from aerial surveys are shown in **Table 13-2**. For the aerial surveys in 2005, Marsh & Lawler (2006) calculated population estimates using both the original method used in previous years and the improved, more accurate method of Pollock *et al.* (2006). The improved method yielded a population estimate of 116 individuals.

Table 13-2 Dugong population estimates for Rodds Bay DPA

Year	Population estimate (SE)	Source
1986	301 (95)	Marsh, 1989
1992	91 (60)	Marsh *et al*., 1996
1994	104 (56)	Marsh *et al*., 1996
1999	55 (37)	Marsh & Lawler, 2001
2005	183 (66) – original method 116 (64) – improved method	Marsh & Lawler, 2006

Professor Helene Marsh (pers. comm., 5/8/08) indicates that the spatially explicit population model of Grech & Marsh (2007), which incorporated the results of aerial population surveys, is a better indicator of the relative importance of Rodds Bay as a dugong habitat than the "snapshot" estimates made in individual aerial surveys. The model indicates that dugong density and relative dugong conservation value is low in the area immediately surrounding Hummock Hill Island, relative to other areas in Queensland (**Figure 13-1**). Model output obtained specifically for the area around Hummock Hill Island (A. Grech, person comm., 6/8/08) indicates that dugongs are likely to occur in most parts of Rodds Bay, and more likely on the eastern side, but again that the dugong population is low relative to other areas of Queensland (**Figure 13-2**). The modelled relative density of dugongs throughout Rodds Bay DPA is <0.15/km^2, and on the western side of Hummock Hill Island mostly <0.04/km^2. This indicates that the Rodds Bay DPA has a low conservation value relative to Shoalwater Bay, Great Sandy Strait, and Moreton Bay, where modelled densities can exceed 1.0/km^2. Note that the density values shown in **Figure 13-1** and **Figure 13-2** should not be interpreted as actual abundance in number of individuals/km^2, but as a probability of occurrence. Thus, a grid cell with a value of 1.0 is likely to have ten times as many dugongs as a cell with a value of 0.1.

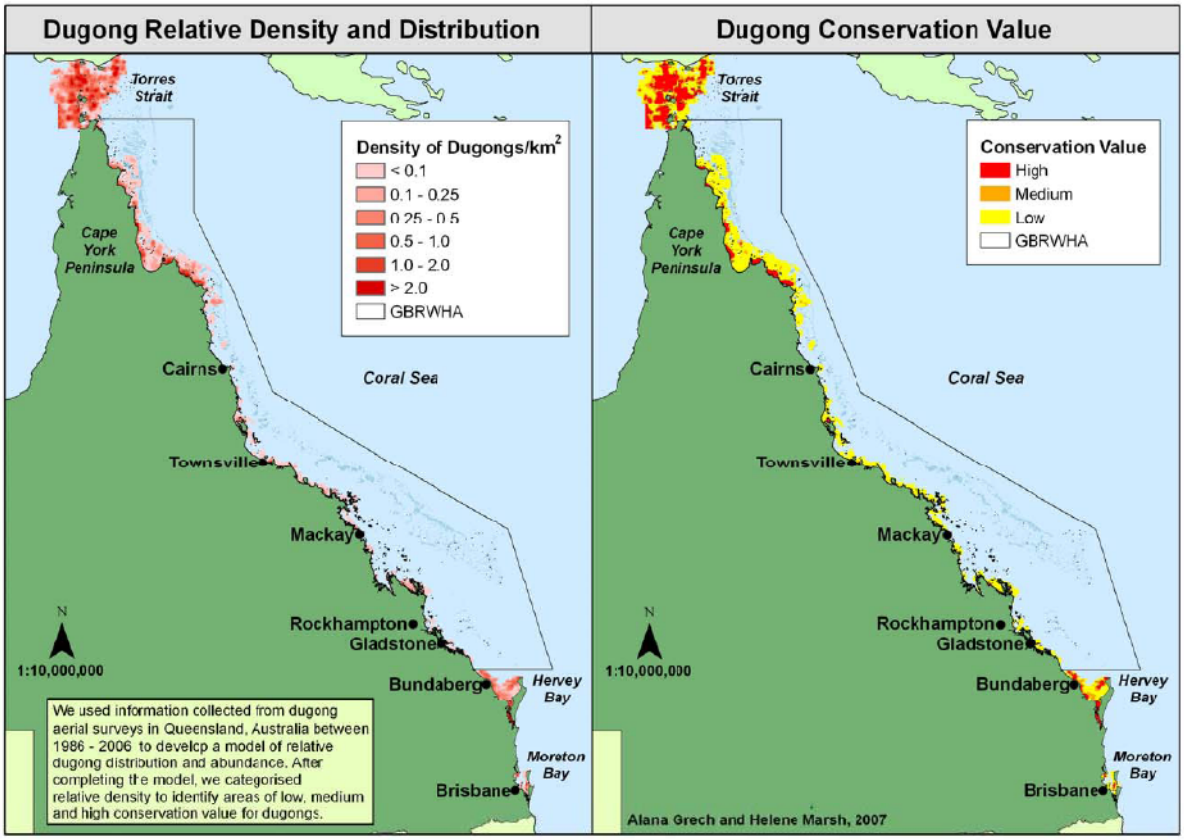

Figure 13-1 Relative dugong density and conservation value on the east coast of Australia based on the model of Grech & Marsh 2007. Source: H. Marsh pers comm. 5/8/08

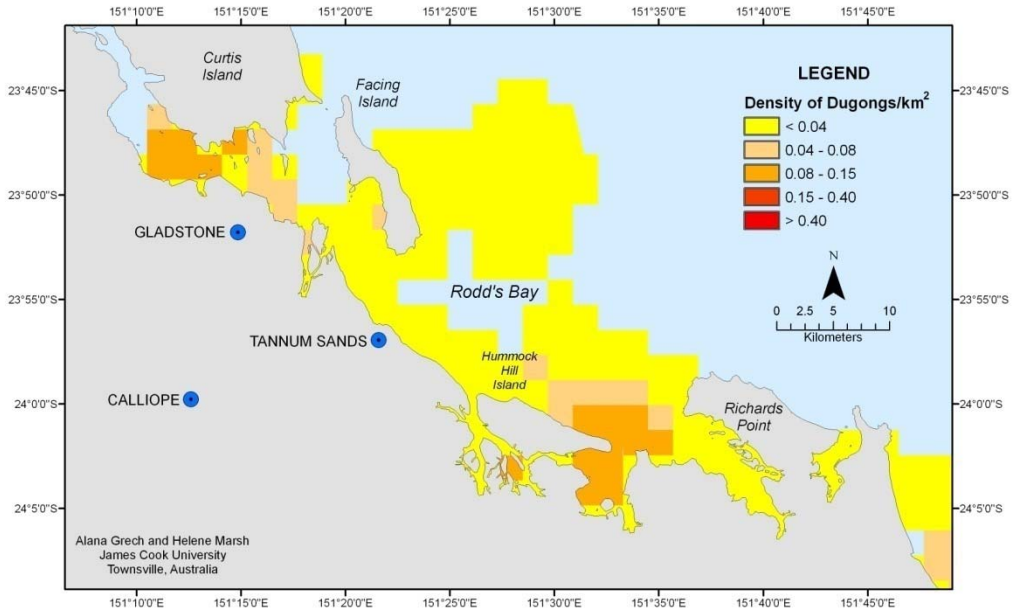

Figure 13-2 Distribution of relative dugong density in the area around Hummock Hill Island, estimated by the model of Grech & Marsh, 2007 (Source: A. Grech)

Marsh & Corkeron (1997) estimated that human-caused mortality of more than 1-2% of the female dugong population per year is unsustainable. More recently, Marsh & Lawler (2006) recommended that for the entire dugong population south of Cooktown, mortality from all human causes should be kept below about 40 individuals per year. They estimated the total size of this population at 5172 individuals, so human-induced mortality should be kept below about 0.77 per 100 individuals per year. Ignoring the likely connectivity of the Rodds Bay dugong population with the larger populations to the north and south, the sustainability of even a single female mortality per year from boat strike is therefore questionable. Even though the model of Grech & Marsh (2007) indicates that the Rodds Bay DPA has a low dugong conservation value relative to Shoalwater Bay, Hervey Bay, Great Sandy Strait and Moreton Bay, dugong mortality from boat strike should be kept as close to zero as possible.

The frequency of boat strikes of dugongs in relation to total vessel use is unknown. Based on total recreational vessel registrations of 179,231 in 2003, and the occurrence of 2-7 boat strike incidents per year from 1998 to 2006 (Greenland & Limpus, 2007), boat strike incidents for Queensland as a whole are rare. More relevant to the area around HHI, some 6,324 private vessels were registered in the Gladstone, Miriam Vale and Calliope shires in 2006 (EIS Table 9.10). DERM (previously EPA) marine wildlife stranding and mortality database annual reports record one boat strike mortality, in 2002, during the period 1998 – 2006 from or within 10 km of the Rodds Bay DPA.

This indicates an average boat-strike mortality of about 0.02 per 1,000 boats per year. It is recognised that an unknown number of dugong mortalities from boat strike may go unreported or be ascribed to "unknown cause", but based on known boat strike mortality the increase in vessel numbers resulting from the development can be expected to result in considerably less than 1 additional dugong mortality annually.

Given the considerable uncertainty associated with the estimated increase in boat strikes on dugongs, mitigation to reduce the boat strike risk is still necessary. As discussed above, appropriate mitigation measures include restriction of vessel speed and public education to increase awareness. Hodgson (2004) concluded that dugongs initiate evasive responses as a function of an approaching vessel's distance rather than its speed, so that when a vessel is moving at speed dugongs will often respond too late to avoid a collision. Reduced vessel speed allows increased time for the animals to react, and also reduces the force of impacts that do occur, and is therefore an appropriate measure to mitigate vessel strike risk. Dugongs' response to boat traffic characteristically consists of rapid swimming to deeper water (Anderson, 1981; Hodgson, 2004; Hodgson & Marsh, 2007, Preen, 1992, 2001). This behaviour is likely to be maladaptive in situations where boats and dugongs are both constrained to narrow channels (Groom *et al*., 2004). In the waters surrounding HHI this is most likely to occur in Boyne Creek and the inner parts of Colosseum Inlet and Seven Mile Creek, and speed restrictions on vessels will be applied for these areas in particular.

Aside from direct boat strikes, dugongs can potentially be affected by disturbance from vessel traffic. Dugongs have been observed to react to boats as far as one kilometre away (Hodgson, 2004; Preen, 1992), but this is unusual. Dugongs usually do not react until boats approach to within 30-50 m and sometimes do not react to boats as near as 1-2 m, even though they apparently detect boats at a range of at least several hundred metres (Anderson, 1981; Hodgson, 2004; Preen, 1992).

Dugongs appear to be most sensitive while in shallow water, where they are probably more vulnerable to boat strikes (Anderson, 1981; Hodgson, 2004; Preen, 1992, 2001).

In addition to eliciting short-term flight reactions, boat traffic might displace dugongs from feeding grounds or other important areas on longer time scales. Avoidance of high-traffic areas has been observed in manatees (Buckingham *et al*., 1999; Gerstein, 2002; Provancha & Provancha, 1988), though it should be noted that this was in Florida where boat traffic is much higher than that which will result from the development. Preen (1992, 2001) describes observations of a negative correlation between dugong abundance and boat traffic level in Australia, but could not determine whether this was due to displacement by boat traffic, or to alternative causes such as the decline of nearshore seagrass beds. Dugong populations often occur near harbours and important shipping lanes, for example in the Arabian Sea, Singapore, Malacca Strait, Malakal Harbor in Palau, as well as Moreton Bay in Brisbane (Marsh et al., 2002). Hodges (2004) considered that dugongs on the Moreton Banks have probably habituated to boat traffic.

The expected increase in boat ownership that will occur with the projected increase in population in the Gladstone Region, will lead to increased risk of dugong strikes and will occur regardless of the development of Hummock Hill Island. The appropriate mitigation measures to manage dugong boat strikes, that are within the Proponent's control, as described in the EIS are restriction of vessel speed and public education to raise awareness and increase compliance with vessel speed limits.

13.2.2 Impacts on Marine Turtles

Submissions have raised concerns regarding the potential for increased boat strike and subsequent mortality of marine turtles.

Boat strikes on marine turtles are typically associated with high boat speeds. Large areas of Colosseum Inlet, Boyne Creek and Seven Mile Creek, particularly the seagrass feeding grounds of dugongs and green turtles, are shallow intertidal areas where boats are less likely to travel at high speed. Increased boat traffic, however, may increase the frequency of boat strikes in the deeper channels. Strategies to minimise boat strikes on marine animals are outlined in the EIS and in **Section 13.2.1** of this document.

A submission raised the issue of potential physical impacts from beachgoers, swimmers, and possibly dogs on the turtle nesting beach on the north side of the island. A public education and awareness campaign highlighting potential physical impacts to turtle hatching sites will be undertaken concurrently with a campaign highlighting the effects of artificial lighting on turtles (as outlined in **Section 13.8**). Additional management strategies to mitigate predation of turtle hatchlings on nesting beaches will be considered. These will include full closure of nesting beaches to dogs during the nesting season.

13.3 Boat Ramps

Submissions raised concerns about the compatibility of boat ramps with impacts to Colosseum Inlet and potential direct impacts of the ramps on dugong and turtle feeding.

The provision of boat ramps for public use is compatible with the designation of Areas of State Significance (Natural Resources). The nearest seagrass community to the proposed Colosseum Inlet

boat ramp identified in the detailed survey of Rasheed *et al*. (2003) is Meadow 81 (see EIS Figure 15.10), approximately 1.5 km from the proposed ramp. The ramp is unlikely to affect dugong and turtle feeding at that distance as supported by findings of Hodgson (2004) and Preen (1992). Meadow 85 is the nearest seagrass community to the proposed Boyne Creek boat ramp, at approximately 300 m away. Disturbance from the boat ramp may be somewhat more likely at Boyne Creek than at the Colosseum Inlet ramp, but as noted above dugongs typically do not respond to boats at that distance. It should be noted that Meadow 85 and the immediately adjacent Meadow 84 run parallel to each other, away from the end of the meadows nearest the proposed boat ramp, for approximately 1.5 km, providing a continuous potential feeding habitat. This is expected to reduce impacts of boat disturbance on turtle and dugong feeding in that there is no habitat fragmentation and animals would not need to move between isolated feeding grounds if disturbed.

No dredging will be undertaken for construction of the proposed boat ramps.

13.4 Pressure on Fisheries

Submissions expressed concerns around the potential for increased pressure on fish and mud crab stocks due to increased recreational fishing/trapping pressure. They also noted that local knowledge indicates a decline in recreational fish catches over time in the area, and ascribed these to population increases.

Based on population numbers and current boat ownership in Queensland, approximately 24% (around 384) of the permanent population of Hummock Hill Island are likely to participate in recreational fishing, with at least 8% (128 people) fishing weekly. DEEDI (previously DPIF) stated in consultations that, despite the anticipated increase in recreational fishing, they consider that current bag limits for recreational fishers are adequate to ensure sustainable catches. Potential impacts on recreational fish stocks from increased use of adjacent estuarine and marine waters are considered minimal.

Anecdotal evidence collected during community consultation also suggests recreational fishing accounts for a decrease in commercial mud crab catch numbers during key holiday periods such as Christmas and Easter. DEEDI indicated in consultations that this may result from poaching of commercial crab pots rather than from increased crab harvest. As with fishes, Queensland DEEDI considers current commercial and recreational limits for mud crabs to be sustainable in the long term.

Recreational fishing will increase as population grows in the Gladstone Region, regardless of the HHI Development. It is expected that the Project will have minimal comparative impact upon fisheries within the region.

13.5 Coral Communities

Submissions suggested that coral communities are present off the coast of HHI, and that the development will result in adverse impacts on those communities. The possible presence of coral communities on patchy rock reefs north of HHI is recognised in Appendix A7.11, Section 3.1.5 of the EIS, although the coral communities surveyed by Alquezar *et al*. (2007) were not specifically identified.

The area identified as "Hummock Hill Reef" by Alquezar *et al*. (2007) extends a distance of approximately 900 m parallel to Main Beach, from about 200 to 900 m offshore. The area lies just east of the discharge of the ephemeral watercourse east of the Northern Headland.

Alquezar *et al*. (2007) surveyed four transects running parallel to the beach at progressive distances of approximately 350 – 600 m offshore. They report depth as ranging from 2.8 – 5.0 m (mean = 4.0 m). Hard coral cover at the most inshore transect was <10 % (percent cover figures presented here are based on results of point-intercept image analysis, estimated to the nearest 5% from histograms presented by Alquezar *et al.*, 2007, who do not present numerical results), but at the other three transects hard coral cover was in the range of 30 – 40%. Alquezar *et al*. describe a trend of increasing coral cover with depth but the highest coral cover was reported from the two transects at intermediate distances offshore, with a slight decrease in coral cover in the outermost transect. Storm wave impact and scouring, surface heating, exposure to a freshwater surface layer during rainfall events, and possibly exposure at low tide (depending on the depth datum used by Alquezar *et al*.) could all contribute to the low coral cover on the shallowest transect.

The observed live hard coral cover of 30 – 40% indicates a significant coral community. It is unlikely that the area represents a structural reef in the sense of a carbonate structure deposited by corals and other organisms given the relatively high (50-75%) sand cover and low (<10 – 20%) pavement cover, instead the communities are likely to consist of rock reefs with covering coral growth, as described in Appendix A7.11, Section 3.1.5, of the EIS. This does not detract from the ecological value of these communities. Alquezar *et al*. (2007) identify the dominant coral species as *Montipora capricornis*, but from inspection of the photographs presented (excluding their Figure 1, which appears to be a stock photo from an offshore reef) this identification is questionable. The coral may be *Turbinaria* sp., which is common in turbid inshore environments.

Submissions expressed concern about potential impacts of land-based pollution on coral communities.

The conceptual stormwater management plan in Appendix A7.2 of the EIS provides for stormwater flows from the Town zone, and possibly from the northern part of the Headland zone, to North Beach via bioretention and detention ponds and an existing depression. In light of the presence of the coral communities approximately 1.3 km to the east on the other side of the Northern Headland, all stormwater flows from the Town and Headland zones will be directed to the south, with no discharge at North Beach south of the Northern Headland.

As discussed below in **Section 13-10**, mitigation measures including Erosion and Sediment Control Plans (ESCP), Water Sensitive Urban Design (WSUD), integrated turf and pest management, the maintenance of a 100 m development buffer from Highest Astronomical Tide (HAT), and the elimination of septic tanks and discharges of treated sewage or desalination effluents to the marine environment are designed to prevent impacts on water quality, and an approved water quality monitoring plan will be implemented to monitor the effectiveness of these measures.

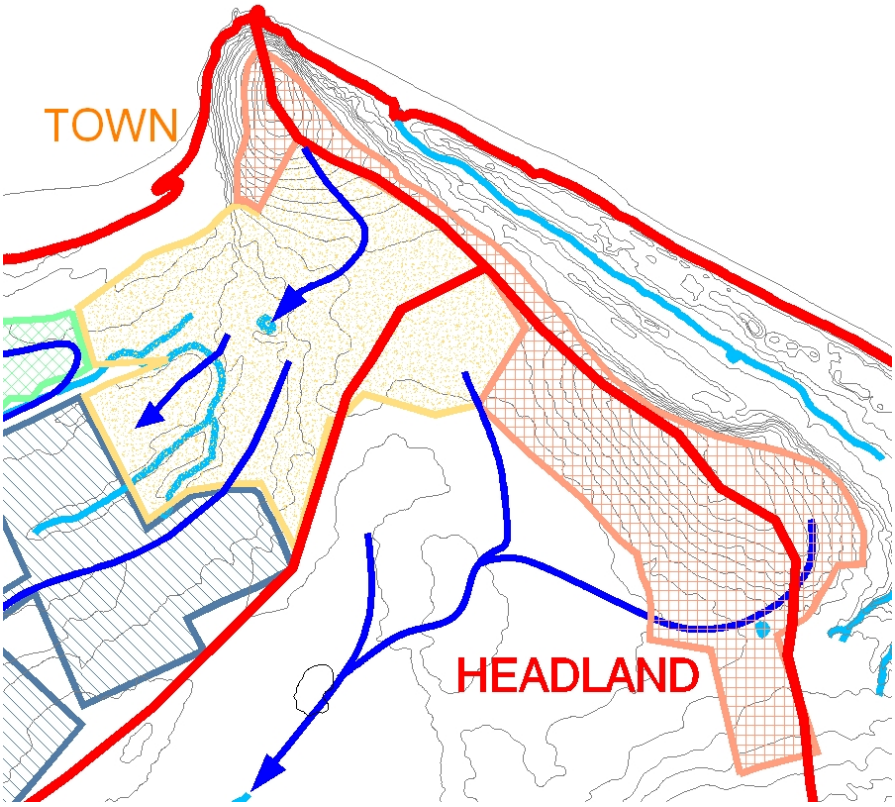

Figure 13-3 Stormwater Flow Headland Zone

Submissions also expressed concern about potential impacts of boat anchoring on coral communities. Public education and awareness efforts including signage at boat ramps and other public areas will promote the use of mitigation measures including voluntary avoidance of anchoring in coral areas and the use of "coral friendly" anchors (reef picks). The installation and maintenance of permanent moorings will be considered and discussed with the appropriate authorities.

Implementation of an approved Marine Ecological Monitoring Plan will allow assessment of the effectiveness of mitigation measures to protect coral communities and the need for alternative or additional measures.

13.6 Seagrass Communities

The presence of significant seagrass communities was identified during community consultation during preparation of the EIS, and the EIS presents the results of the detailed survey conducted by Rasheed *et al*. (2003). Submissions expressed concern about potential impacts on seagrass beds in the area through the degradation of water quality due to terrestrial runoff, both with respect to the importance of seagrass beds for dugongs and turtles and also in relation to the inherent importance of seagrasses in relation to World Heritage and other ecological values.

The mitigation measures described in the EIS and listed in **Section 13-10** below, including ESCP, WSUD, integrated turf and pest management, the maintenance of a 100 m development buffer from HAT, and the elimination of septic tanks and discharges of treated sewage or desalination effluents

to the marine environment are designed to prevent impacts on water quality, including pollution from sediments, nutrients, and herbicides, to which seagrasses are particularly sensitive. An approved water quality monitoring plan will be implemented to monitor the effectiveness of these measures in maintaining water quality and the health of seagrass communities will be directly monitored through the implementation of a Marine Ecological Monitoring Plan.

13.7 Impacts of Pollution on Marine Systems

13.7.1 Pollution Sources

Submissions expressed concerns in relation to the potential for increased sediment, nutrient, chemical and solid waste (litter) pollutant loads leaving the island as a result of the development.

As identified in the EIS, the transport mechanism for pollutants would be via storm water flows in identified ephemeral watercourses discharging to Boyne Creek and Colosseum Inlet from disturbed areas within the development area.

The development of ESCP and WSUD for permanent storm water controls will be effective in managing sedimentation, suspended sediment, hydrocarbons, litter, nutrients, pesticides, herbicides and fungicides through various treatment trains. Pollutant export from the island is considered unlikely to increase significantly as a result of the development.

One submission expressed concern about an increase in litter entering Colosseum Inlet as a result of littering from vessels. Littering from vessels can be mitigated by providing waste and recycling bins at the boat ramps and marine centre, with regular collection, as well as public awareness/education measures such as signage and advertisements.

13.7.2 Water Quality Monitoring Program

Submissions requested further details of the water quality monitoring plan to allow assessment of the adequacy of the plan. While the Queensland Water Quality Guidelines and ANZECC guideline provide default Water Quality Objectives, locally derived sub-regional guidelines would be much more relevant to this development.

In addition to implementing ESCP and WSUD, the Proponent Commitments include the development and implementation of a Water Quality Monitoring Plan (WQMP) to establish local water quality objectives (WQOs). This will be undertaken during the period development approvals are being gained through Material Change of Use process and before construction. The WQMP will be approved by DERM. The Proponent propose the WQOs be approved by both DEWHA and DERM as a Condition of Approval. The WQMP will be designed in accordance with the Queensland Water Quality Guidelines (QWQG) (EPA 2006), the ANZECC/ARMCANZ (2000) Guidelines and the Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA 2009), which outline monitoring strategies and guideline values for water quality parameters.

The established Port Curtis Integrated Monitoring Program (PCIMP), which includes yearly water quality monitoring at 16 sites around Hummock Hill Island and Colosseum Inlet, may provide background water quality data, which will be reviewed in detail during development of the WQMP.

In any case, the WQMP will commence prior to construction in order to collect baseline water quality data and establish local WQOs.

The WQMP will include water quality sampling at a minimum of five potential impact locations, plus a minimum of two reference locations. The impact locations will notionally correspond to locations W1, W2, W5, and W8, as shown on Figure 9.8 of the EIS, as well as an additional location at the mouth of Sandfly Creek. The precise monitoring locations, however, will be adjusted in order to integrate the water quality monitoring with ecological monitoring. For example, it is envisaged that location W2 may be moved to the east side of the northern headland to provide better association with anticipated coral monitoring sites at the coral community described by Alquezar *et al*. (2007); this is also appropriate in light of the elimination of the previously planned stormwater discharge just west of the headland. It is also anticipated that location W5 may be moved slightly south to better reflect water quality conditions at seagrass meadows 84 and 85 as designated by Rasheed *et al*. (2003) (see EIS Figure 15.10). The monitoring locations for baseline and subsequent construction and operational monitoring will be determined on the basis of field surveys, and additional sites may be added during development of the WQMP.

The parameters to be monitored, relevant guideline values and laboratory levels of reporting (LORs) are shown in **Table 13-3**. Additional parameters may be added during development of the detailed WQMP.

Table 13-3 Water Quality Monitoring Program monitoring parameters

Parameter	Unit	Relevant Guideline Values	Level of Reporting
Total Suspended Solids	mg/L	10-20	<5
Chlorophyll-a	µg/L	1-4	<0.15
Nutrients			
Total Nitrogen	µg/L	140-300	<50
Ammonia (as N)	µg/L	6-10	<3
Oxides of nitrogen (as N)	µg/L	3-10	<2
Filterable reactive phosphorus	µg/L	6-8	<2
Total iron	µg/L	N/A	<10
Dissolved iron	µg/L	N/A	<10
Metals			
Zinc	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<5
Selenium	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<**3**
Nickel	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<**1**
Manganese	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<10
Copper	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<**1**
Cobalt	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<1
Aluminium	µg/L	ANZECC 2000 Guideline trigger values for toxicants	<0.5

Parameter	Unit	Relevant Guideline Values	Level of Reporting
Pesticides and Herbicides			
Diuron	µg/L	ANZECC 2000 Guideline trigger values for toxicants	3
Organochlorines	µg/L	ANZECC 2000 Guideline trigger values for toxicants	0.5-2
Organophosphates	µg/L	ANZECC 2000 Guideline trigger values for toxicants	0.5-2

The guideline values for total suspended solids, chlorophyll-a and nutrients are presented in **Table 13-3** simply for information and sub-regional WQOs will be established on the basis of bi-monthly sampling to generate a minimum of 24 data points over 12 months. WQO's for metals and pesticides, will be those specified within Table 3.4.1 of the ANZECC/ARMCANZ 2000 Guidelines (trigger values for toxicants) – 95% protection. Sampling will be performed on the same stage of the tide (2 hours after high tide) to provide consistent results. Future monitoring will require the same sampling approach for consistency in tidal conditions and hence comparison of results. All sampling will be conducted in accordance with the most recent available version of the Queensland DERM (previously EPA) Water Quality Sampling Manual (currently 1999). Laboratory analysis will be conducted by a NATA-accredited laboratory, with field duplicate samples sent to a second laboratory for inter-laboratory quality control purposes at each sampling event. The Queensland Health Forensic and Scientific Services (QHFSS) laboratory will be used as the primary or quality-control laboratory. Each monthly water sampling event will also include profiling of temperature, salinity, dissolved oxygen, pH, and turbidity at each monitoring location. Sub-regional Water Quality Objectives (WQOs) for total suspended solids, chlorophyll-a, and nutrients will be derived as 20th and 80th percentiles of the baseline monitoring data, in accordance with ANZECC/ARMCANZ and Queensland Water Quality Guidelines. Depending on baseline monitoring results and other available information, separate WQOs may be established for sub-groups of monitoring locations to take into account variation in water quality among different water types.

In addition to the monthly monitoring described above, continuously recording *in situ* turbidity meters will be deployed at a minimum of two locations, one in Boyne Creek and one in Colosseum Inlet, for a minimum of one month during the summer and one month during the winter, during the baseline monitoring program. *In situ* turbidity meters will also be deployed for at least the first month of major phases of construction to assess the performance of sediment control measures.

13.7.3 Reef Water Quality Protection Plan

The Reef Water Quality Protection Plan (RWQPP) aims to address pollution from a range of diffuse sources within catchments that flow into the Great Barrier Reef. The Plan includes a number of strategies that set out actions to minimise pollutants from diffuse sources and reducing their entry to the Reef. The Plan has defined diffuse sources as those that enter the waterways through a wide range of different sources and which cannot be directly attributed to one point of dispersal, such as a pipe or waste outlet and include nutrients, chemicals and sediment which wash into waterways and ultimately flow into the Reef lagoon.

The RWQPP has the goal of halting and reversing the decline in water quality entering the Reef within 10 years. It has two objectives, which are:

- Objective 1 - reduce the load of pollutants from diffuse sources in the water entering the Reef; and
- Objective 2 - rehabilitate and conserve areas of the Reef catchment that have a role in removing water borne pollutants.

The RWQPP has identified a number of ways these objectives can be achieved. Objective 1 can be achieved through sustainable practices and better land use decisions, while Objective 2 can be meet through conservation and rehabilitation actions. **Table 13-4** shows how the HHI Development will work achieve these objectives.

Table 13-4 RWQPP objectives and HHI Development commitments

Objective 1 - reduce the load of pollutants from diffuse sources in the water entering the Reef	
Sustainable Practices	■ The project is committed to reducing the volume of treated water needed by the development by including rainwater tanks, grey water reuse to irrigate public areas such as golf course and airstrip. ■ Wastewater will not be deliberately released from the development, to the ocean. All wastewater will be collected and treated for reuse within the development. ■ A comprehensive water sensitive urban design system will be designed and constructed to manage and treat stormwater from the development, using a system of constructed wetlands. ■ Sediment and erosion control plans will be used within the project to reduce the limit erosion and reduce the loss of sediment from the development.
Better Land Use Decisions	■ The project will be developed on the basis of a Master Plan that has been prepared in recognition of the natural values of the Island. ■ The design of the development has been completed to protect waterways, wetlands, coastal systems and habitat, with substantial buffers around sensitive areas been allowed, to protect these areas.
Objective 2 - rehabilitate and conserve areas of the Reef catchment that have a role in removing water borne pollutants	
Conservation	■ The part of HHI not included within the development footprint of the project will be managed for conservation purposes, with a nature refuge or similar covenant to be negotiated with the government agencies. ■ Covenants will be placed over areas of vegetation offsets secured by the Proponent, so that these offsets will be protected from clearing. ■ The project will include a program of community engagement delivered by an environmental management contractor with the Proponent to engage the tourists and residents of the Island in conservation related programs, deliver a program of weed management, fire management and pest management to reduce threats to wildlife and habitat of the Island. ■ The Proponent will work with the Island community to increase knowledge and awareness of the natural values of Hummock Hill Island and the Great Barrier Reef and will include programs on boat use, to reduce impacts on marine wildlife, understand of turtle use of Island beaches, values of wetlands in protecting the values of Hummock Hill Island and the Great Barrier Reef and how to live on the Island in a manner that recognises the Island's conservation and natural resource management values.
Rehabilitation	■ The Proponent will actively undertake the rehabilitation program to improve the quality of bushland and habitat through revegetation, weed control, fencing and management of access to areas being rehabilitated. ■ The Proponent will secure vegetation offsets, specifically to address the impact of vegetation clearing to be undertaken for the project. The Proponent will manage

	these offsets, to ensure that they reach remnant vegetation status. These areas of vegetation offsets will be located on both Hummock Hill Island and on the nearby mainland, within 20 km of the Island. ■ All areas directly impacted during construction of the project will be rehabilitated using local native species, with the purpose of re-establishing native vegetation communities, providing habitat for local native species and protecting water quality, waterways and wetlands of the Island.

13.8 Artificial Night Lighting

The development will include features that will minimise impact on the turtle nesting areas of the Island. These areas are on North Beach and Main Beach, next to Northern Headland. These areas have been used for nesting by turtles, however DERM considers the sites not to be major nesting areas, as stated in Section 15.1.3.2 of the EIS.

The EIS contains an analysis of issues relating to light spillage, particularly potential impacts on marine turtle nesting behaviour. The turtle rookery is presently affected by light from the Gladstone-Tannum Sands area. Mitigation of such effects from the development will be specified in an Artificial Lighting Management Plan (ALMP) to be prepared subject to project approval. The ALMP will be prepared on the basis of a line-of-site survey that will generate a map of visibility zones. These zones will be defined by the height (notionally, <1 m, 1-2 m, 2-3 m, 3-5 m, >5 m) at which objects are visible from the beach between the low water mark and the landward extent of nesting on Main Beach.

The ALMP will employ an integrated strategy incorporating a mix of measures, consistent with the approach recommended by Witherington & Martin (2003). In broad terms, the strategy will include a hierarchy of approaches as outlined in the EIS:

- Elimination of unnecessary lighting, including the incorporation of recognised building design features;
- Technological measures to eliminate or reduce light cast to the beach (e.g. reduced brightness, shielding, directionality, lower height, motion sensors or timers to ensure short-duration lighting);
- Landscape design measures including the use of vegetation screens and curved roads and paths;
- Use of long-wavelength lights, which are less visible to turtles; and
- Education and awareness raising for designers and engineers as well as residents and visitors.

The mitigation measures required will depend upon the visibility zone and specific lighting application, and will be specified in the ALMP after visibility mapping at the detailed design stage. Examples of specific expected measures include:

- Low-height, louvered bollard fixtures for road and car park lighting;

- Louvered step lighting on balconies, coupled with solid outer balcony walls rather than railings and yellow light sources.
- Opaque awnings over seaward-facing windows that eliminate lateral light cast, coupled with window tinting;
- Elimination of all upward-directed lighting such as feature lighting on buildings and trees;
- Planting or rehabilitation of screening vegetation;
- Use of "turtle-friendly" light sources (yellow and where possible red wavelengths) for all public lighting.

Visual surveys will be undertaken after each significant stage of development to identify and rectify lighting that is visible from the beach, arising from the project. The methodology and frequency of the surveys will be specified in the ALMP.

Measures for public lighting and building design and construction will be undertaken as a commitment of the developer and operators, and will be reinforced by awareness training for architects, engineers, and builders. Measures such as fixture design and placement that are built-in to buildings and public lighting are likely to require little active enforcement. Measures related to domestic spaces of permanent residents will be selected to enhance acceptability and reduce the need for enforcement. For example, the yellow exterior lights have the advantage of not attracting insects, window awnings and tinting keep rooms cool, and light timers and motion sensors reduce energy costs. The Proponent will provide education programs for tourists and local residents to promote awareness of the potential to impact on both the terrestrial and marine environments and take responsibility for the local environment.

13.9 Impacts of Desalinisation Intake

Submissions have raised the issue of potential impacts on marine fauna at the desalinisation plant intake point.

The potable water requirement for HHI Development has been determined to be 441 kL/d. If the MVC desalination technology is adopted, the required volume of water to produce 441 kL/d is approximately 550 kL/d. This is a very small desalination plant requiring an intake pipe of approximately 250 mm.

It is proposed that seawater will be extracted from Boyne Channel via a seawater intake pump located on the northern (island side) pier of the bridge. The pump will be programmed to pump seawater during the upper half of the tidal cycle to ensure a consistent quality of raw water.

Measures to reduce entrainment of marine organisms in the intake of the desalination plant will be determined during detailed design. These measures will include:

- design to achieve the minimal practical water velocity at the intake;

- a “velocity cap” that produces horizontal intake currents, which fish are able to detect better than vertical currents; and
- incorporation of a travelling screen/fish return system at the intake to prevent the entry of fish and where possible release them unharmed.

Such measures are considered by the California Coastal Commission (2004) as "Best Technology Available" for the purposes of compliance with the US Clean Water Act.

13.10 Buffers to Fisheries Habitat Areas

Submissions have expressed concern in relation to the adequacy of buffer zones to Fish Habitat Areas, marine ecosystems and intertidal zones.

The Fish Habitat Management Operational Policy for the Management of Fish Habitat Areas (FHMOP 002, September 1996 edition) in Queensland outlines the departmental policy position concerning the protection and management of fish habitat. Section 4B of FHMOP 002 relates to the establishment of buffer zones in Fish Habitat Areas. The current policy provides primarily for marine areas as no freshwater Fish Habitat Areas have been gazetted to date.

The Department of Employment, Economic Development and Innovation (previously DPIF), has adopted a generic policy position which recommends a minimum buffer width of 100 m (incorporating natural vegetation and other buffer elements) set back from the level of HAT in tidal areas.

The development layout has been amended to accommodate buffers of at least 100 m to HAT and is therefore consistent with DEEDI Policy.

13.11 Impacts on World Heritage Values

Several submissions expressed the view that the development would adversely impact the World Heritage Values associated with HHI. Most of the values identified for the GBRWHA against the World Heritage Area listing criteria relate to the marine ecosystem, in particular the large number and biological and geomorphological diversity of coral reefs, the geomorphological and biological interconnectivity of reefs and islands, north-south marine biodiversity gradients, spectacular reef and island seascapes, and the presence of key habitats for species of conservation significance.

In relation to impacts on these values, the following key points are noted:

- discharge of pollutants (sediments, nutrients, other chemicals, litter) to the marine environment can be effectively managed to meet Water Quality Objectives through ESCP, WSUD, integrated turf and pest management and the elimination of septic tanks and discharges of treated sewage or desalination effluents to the marine environment;
- impacts on threatened or listed species such as dugongs and turtles within the marine environment are considered manageable to an acceptable level of risk by preventing degradation of seagrass beds and other key habitats from declining water quality and reducing risk of vessel strike through reduced vessel speeds and public awareness programs;

- impacts of artificial night lighting can be effectively mitigated by development and implementation of an Artificial Lighting Management Plan;
- a range of standard design specifications will minimise the risk of the desalinisation intake to marine fauna by the implementation of technological measures such as low intake velocities, a velocity cap, and/or travelling screens;
- there will be limited direct impact on marine habitats as a result of keeping direct losses as low as possible, representing 0.014% and 0.002% of the mangrove and supratidal salt pan habitats, respectively, within the Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek intertidal wetland system ; and
- buffers of at least 100 m will be maintained between development areas and Highest Astronomical Tide, increasing the level of protection to intertidal ecosystems.

The environmental values of the GBRMP and the GBRCMP are concordant with those of the GBR World Heritage Area, and their maintenance is discussed in Section 15 and other relevant sections of the EIS. The maintenance of intertidal wetland values and functions is specifically addressed in Section 15.3.2.4 and Table 15.14.

13.12 Marine Ecological Monitoring

To assess the effectiveness of mitigation measures for potential impacts on marine communities in the area, and identify possible requirements for alternative or additional measures, the Proponent Commitments include the development and implementation of a Marine Ecological Monitoring Plan (MEMP) to map and monitor key marine communities in the area including coral communities, seagrass beds, and mangroves. Monitoring methodology including sites, frequencies, and specific techniques will be developed on the basis of field surveys, mapping and characterisation of existing communities in the area and specified in the plan. The plan will include baseline monitoring including at least two seasonal monitoring events (winter and summer) over at least 12 months.

13.13 Impacts of Bridge and Roadway on Tide or Flood Flows

Submissions raised the issue of the potential interruption of tidal and flood flows and geomorphology in Boyne Creek by the proposed bridge and roadway. The Proponent agrees to the following commitments:

- The bridge, bridge abutments, and any associated structures will be designed and constructed in a manner that does not result in any reduction of existing tidal flows. The maintenance of tidal flows will be verified through modelling based on detailed design prior to commencement of construction.
- The existing causeway will be removed subject to project approval. This is expected to result in a considerable increase in tidal flows in Boyne Creek with a return to more natural flow levels.

13.14 EIS Amendments

- In the list of abbreviations for Volumes 1 and 2, the definition of the acronym for GBRCMP should be amended to "Great Barrier Reef Coast Marine Park".

- Paragraph 1 under *"Nature Conservation – Marine"* on page 22 of the Executive Summary should be amended to read:

  "Hummock Hill Island is situated on the landward boundary of the Great Barrier Reef Marine Park (GBRMP). Hummock Hill Island also lies within the Great Barrier Reef Coast Marine Park (GBRCMP), which is administered by Queensland Government. The Great Barrier Reef World Heritage Area (GBRWHA) includes Hummock Hill Island itself as well as the surrounding waters including Colosseum Inlet, Boyne Creek and Rodds Bay."

- The Proponent commitment relating to clearing within supratidal salt flats and mangroves on page 35 of the executive summary should be amended to read:

  "Clearing within supratidal salt flats and mangroves will be minimised to the minimum width required to accommodate the road design, boat ramps and storm water controls. Clearing will be conducted in accordance with conditions of approval under the Integrated Planning Act 1997 (Coastal Protection and Management Act 1995, Fisheries Act 1994 and Marine Park Act 2004).

- Section 15.1.1.2 should be amended to read:

  "Hummock Hill Island also lies within the Queensland State Great Barrier Reef Coast Marine Park (GBRCMP). The GBRCMP includes all waters up to HAT in Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek, as well as intertidal waters along the ocean-facing side of Hummock Hill Island. The GBRCMP provides protection for Queensland tidal lands and tidal waters within the Great Barrier Reef Region, including tidal rivers, creeks and mangrove areas. The Zoning Plan for the GBRCMP complements the GBRMP Zoning Plan and adopts similar zone objectives, as well as entry and use provisions. The GBRCMP in the Hummock Hill Island area imposes the same restrictions that apply to the General Use Zone of the Commonwealth GBRMP. The boundaries of the GBRCMP are provided in Figure 15.1."

- Paragraph 4, Section 15.1.1.2 should be amended to read:

  "Colosseum Inlet and the western part of Boyne Creek and Seven Mile Creek are zoned Management A".

- Table 15.15 of the EIS lists Fish Habitat Areas as an Area of State Significance (Natural Resources). Table 15-15 should remove the row for Fish Habitat Areas.

- Section 15.1.1.2 should be amended to read:

  "The boundaries of the GMRMP, GBRWHA and GBRCMP are shown in Figure 15-1."

- The paragraph in Section 9.2.2 reading "Intertidal resources surrounding the Island and border the mainland provide habitat for commercial" should be deleted.